SECTION 4:

HOPE ISLAND, URCHIN DENSITY MANIPULATIONS

INTRODUCTION

At Hope Is, preliminary short term trial clearings of urchin from barrens resulted in little recovery of macroalgal vegetation. This indicated that intended clearings of urchins at this site to improve roe quality would be unlikely to succeed as there was no subsequent increase in available food. It was postulated that limpets may be an additional herbivore controlling vegetation so the following experiment was conducted to determine if urchins were the principal herbivore at Hope Island.

METHOD

To determine the cause of the barrens on the island, four treatments were proposed. These were:

1. No urchins (U)
2. No urchins, abalone and limpets (UAL)
3. No abalone or limpets (AL)
4. Control (C)

These were done in quadruplicate for 16 squares divided off by approx. 50 cm high netting. The squares measure 10m x 7.5m. There are two blocks of four squares each on each side of the island with randomly allocated treatments.

Monitoring was conducted using 10 1 x 1m quadrats within each of the squares for counts of urchin, abalone and limpets. Quadrats were regularly arranged in the square: one at each of the corners, one at each of the mid points of the sides and two in the middle. Ten 0.5 x 0.5 m quadrats (50 point intercept) are used for the algae placed within the 1 x 1m quadrat used for urchin numbers.

In order to provide a source of spores, as spore availability may affect re-vegetation, *Macrocystis* plants were introduced to each of the squares. Ten plants were placed in each. Juvenile plants (0.2-1.0m high) were obtained from Dodges Ferry, kept moist under hessian sacks and within 24 hours of harvest, replanted at Hope Island in June 1994. Individual plants were attached to bricks using rubber bands over the haptera at the base of the plant. A further aspect of this experiment was to determine if urchins or limpets were controlling factors in *Macrocystis* populations at Hope Island. Urchin divers maintain that best roe recovery comes from urchins harvested from beds of *Macrocystis*.

Monitoring was conducted approximately once every four months after the pre-harvest survey. Minimal change was observed in re-vegetation for the first spring-summer period over which the experiment was conducted (1994) so it was run until spring-summer of the second year (1995). Clearing sessions were conducted at the beginning of the experiment (June 1994) and again in the autumn of 1995. The first monitoring session after the first clearing, showed abalone densities were not significantly different from the initial pre- first clearance survey. It was assumed that the nets were being transversed by the abalone and because density levels of these animals were low and thus likely of limited effect, abalone were not included in subsequent harvests.

RESULTS

Results for the manipulation experimants are depicted in Figs: 4:1 - 4:5. Limpets did not have a significant effect on the percentage cover of algae; filamentous, annual or perrenial recorded in the squares while urchins were highly significant. Time of monitoring is also highly significant. This is not surprising as there are seasonal differences in growth of the algae concerned.

TABLE 4.1

Analysis of variance on total algal cover on urchin cleared squares. Data for total algal cover was logged to normalise residual ditribution.

Dependent variable: Log Total algal cover, n: 16

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
Block	4.305	3	1.435	8.932	0.006
Urchin treatment:	2.556	1	2.556	15.907	0.004
Block* Urchin treatment:	0.567	3	0.189	1.176	0.378
ERROR	1.285	8	0.161		

After four months, *Macrocystis* plant numbers were at significantly lower numbers in the squares with reduced levels of urchins (Fig. 4.5, Table 4.2). Later recruitment of *Macrocystis* plants was greater into the squares with reduced levels of urchins (Table 4.3).

TABLE 4.2 ANOVA on effect of urchin clearance on survival of transplanted Macrocystis plants four months after.

Dependent variable: Log No. Macrocystis plants in October 1994, n: 16

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
Block	1.733	3	0.578	2.475	0.136
Urchin treatment:	5.696	1	5.696	24.403	0.001
Block * Urchin treatment:	0.715	3	0.238	1.021	0.433
ERROR	1.867	8	0.233		

TABLE 4.3 ANOVA on effect of urchin clearance on subsequent recruitment of *Macrocystis* plants into squares 23 months later.

Dependent variable: Log No. *Macrocystis* plants in May 1996, n: 16

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
Block	0.921	3	0.307	0.473	0.710
Urchin treatment:	10.808	1	10.808	16.634	0.004
Block * Urchin treatment:	3.315	3	1.105	1.700	0.244
ERROR	5.198	8	0.650		

DISCUSSION

Two years later, an area that had been regularly cleared of urchin outside of treatment areas still did not have significant amounts of vegetation. It is thus quite likely that the reason for not becoming re-vegetated was due to a lack of a source of algal spores.

We have shown here that manipulations of urchin densities can result in increasing amounts of vegetation, and preferred species can be introduced. At these sites, while *Macrocystis* was a dominant algae that re-established itself in the cleared areas, a non-preferred alga also was evident namely: *Sargassum* sp. (*fallax*?, Fig. 4.6). *Sargassum* sp. are known to be high in polyphenolics (anti-herbivore secondary metabolites). This alga established itself in deeper waters with respect to *Macrocystis*. Urchin divers acknowledge that areas where *Sargassum* ('sticky weed') has established itself are poor recovery areas for urchin roe.

Unfortuneately, the experiment did not progress for sufficient time to determine the effect on roe of urchins associated with re-established *Macrocystis*, but it can be assumed from *Macrocystis* harvested urchins from nearby (Hope 5S) that they will improve.

FIGURE 4.1 Results of regular surveys within the squares at Hope Island.

LIMPET REMOVAL

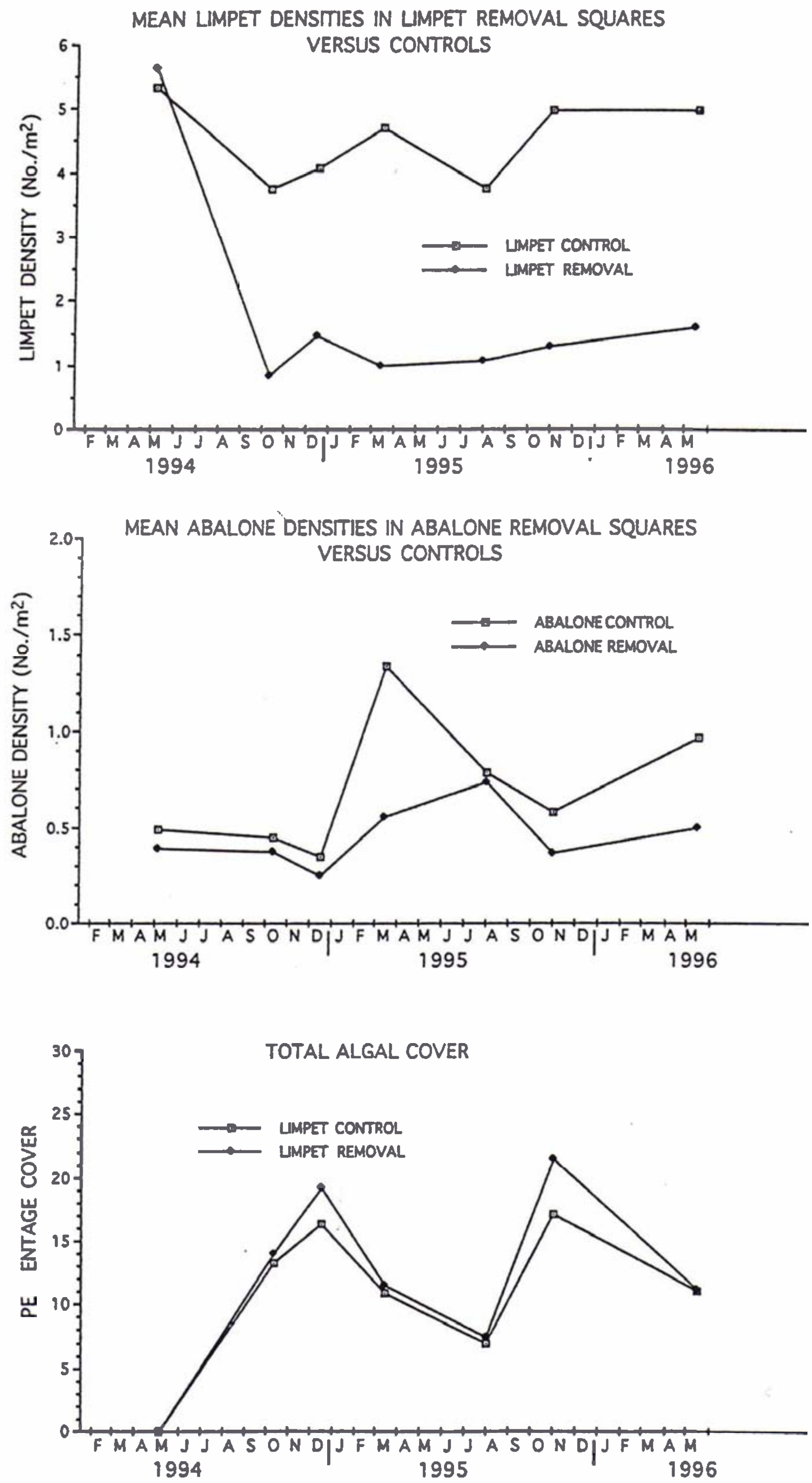
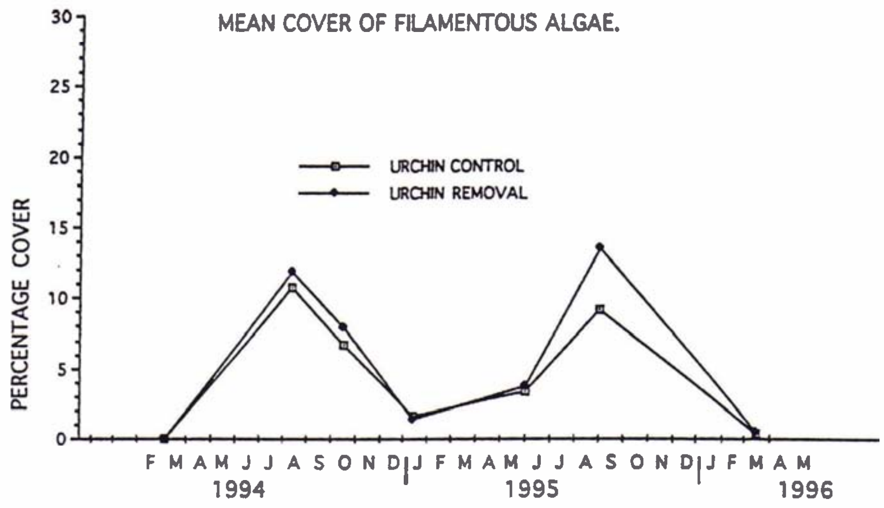
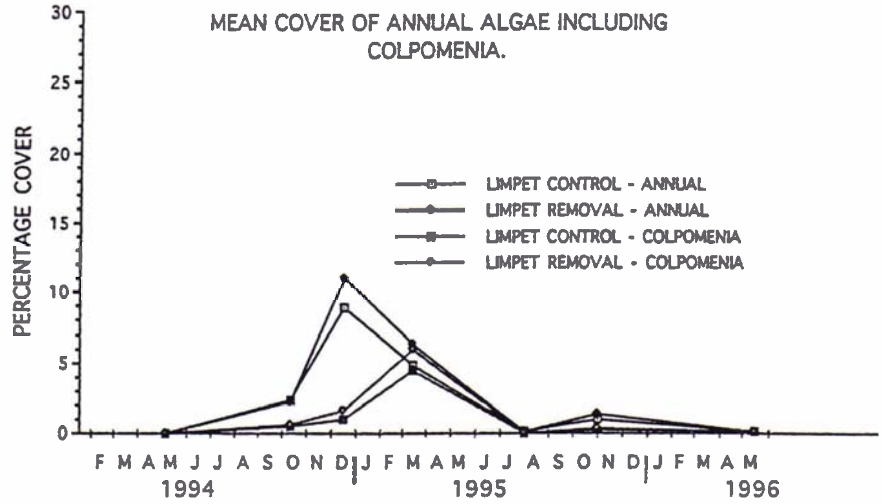


FIGURE 4.2 Results of regular surveys within the squares at Hope Island.

LIMPET REMOVAL





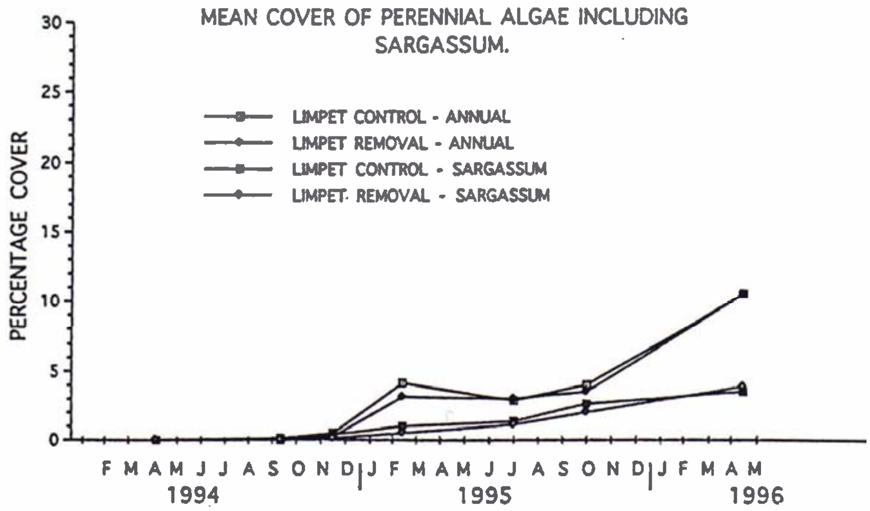
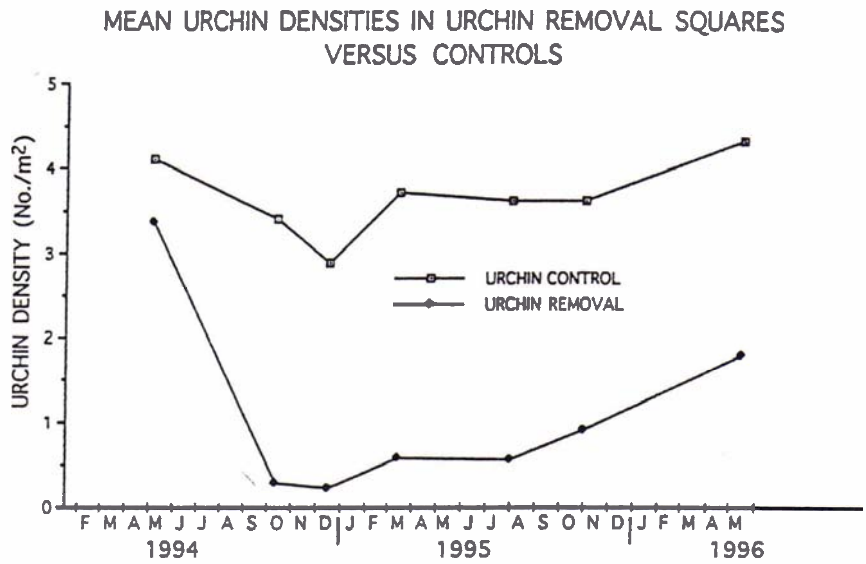


FIGURE 4.3 Results of regular surveys within the squares at Hope Island.

URCHIN REMOVAL



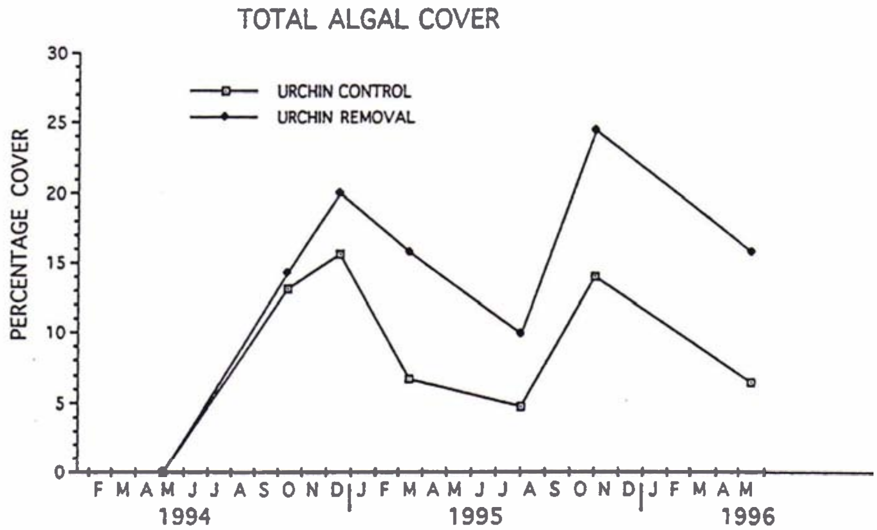


FIGURE 4.4 Results of regular surveys within the squares at Hope Island.

URCHIN REMOVAL

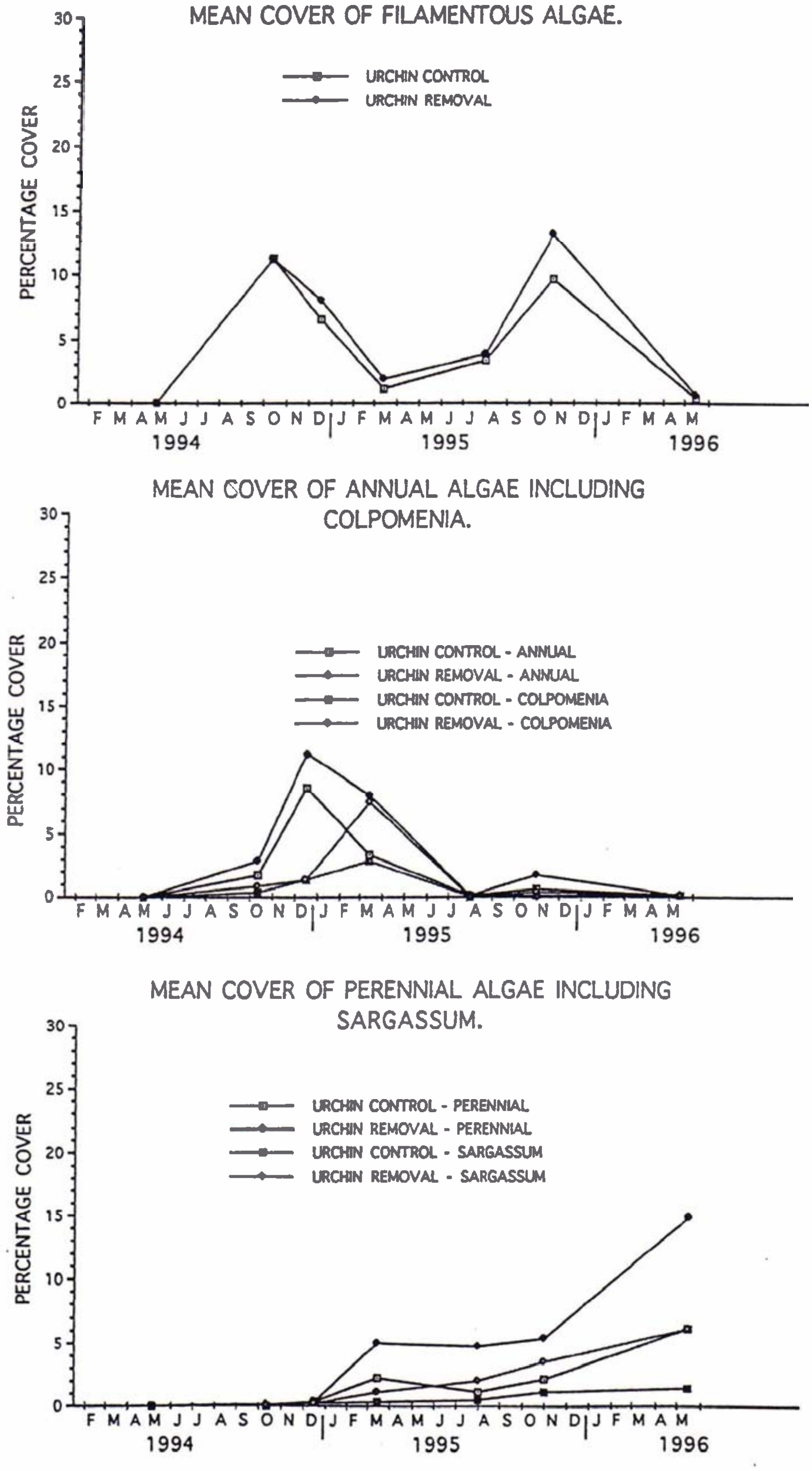
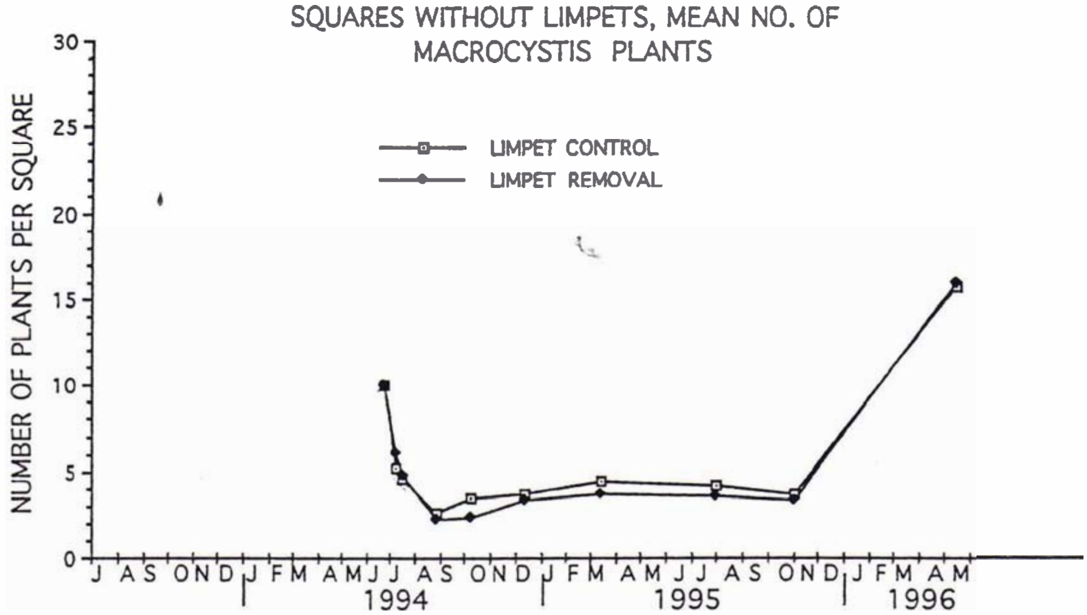


FIGURE 4.5 Results of regular surveys within the squares at Hope Island, *Macrocystis* transplants.



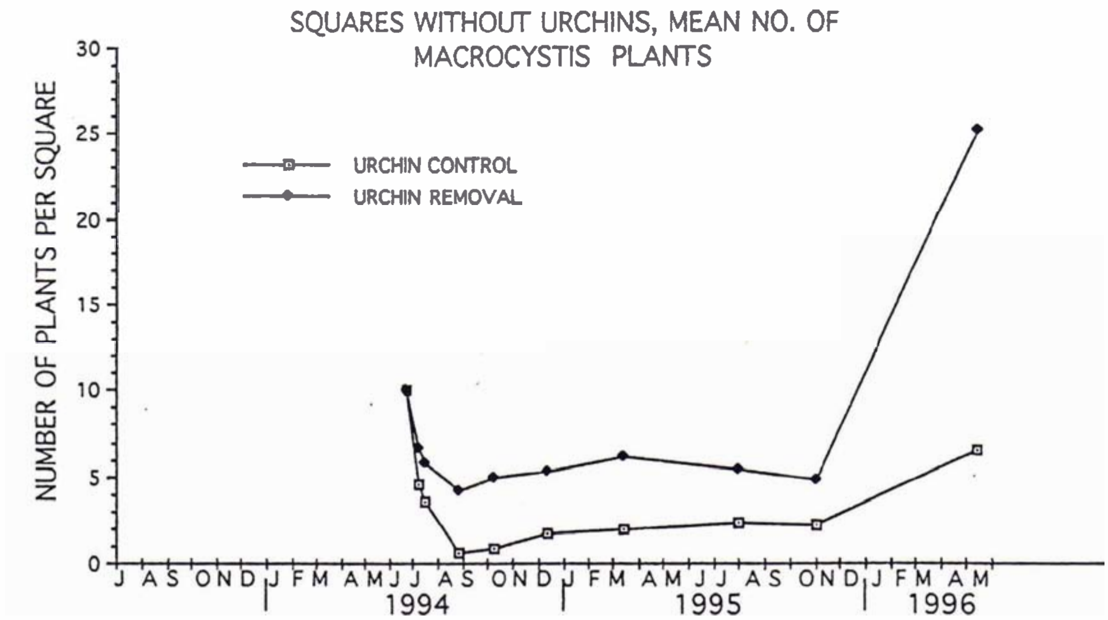
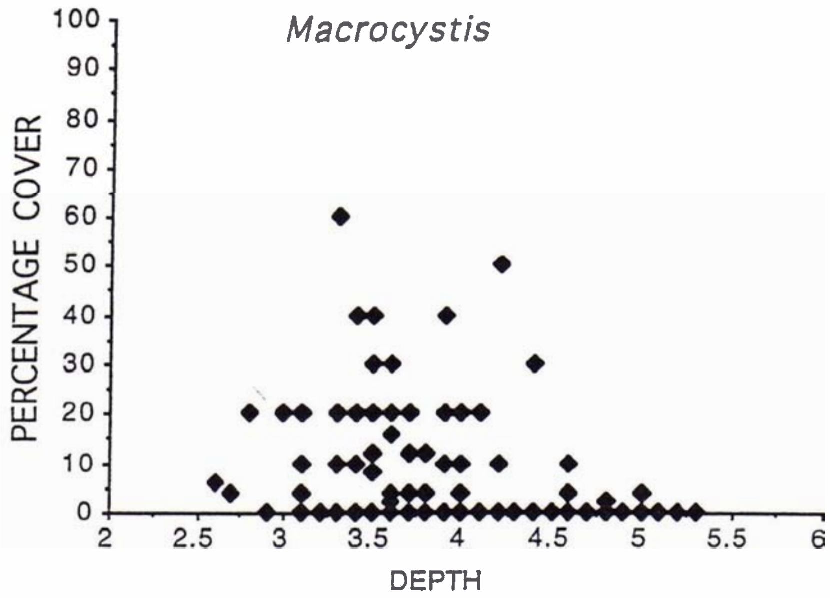
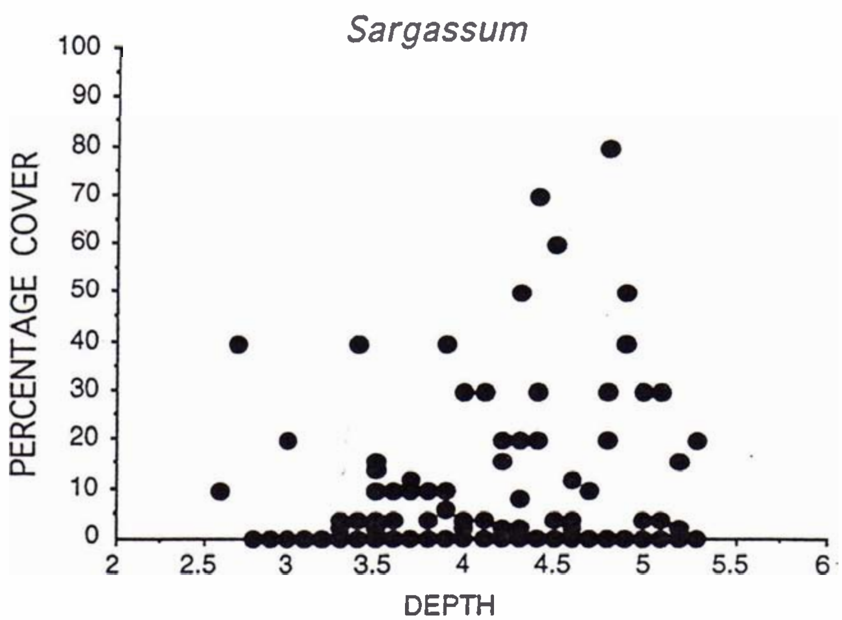


FIGURE 4.6 Diagrams showing variation in the distribution of *Macrocystis* and *Sargassum* with depth from survey results.





SECTION 5: *MACROCYSTIS PYRIFERA*

INTRODUCTION

Urchin divers claim that urchins with best quality and quantity roe come from *Macrocystis pyrifera* beds. If *Macrocystis* could be grown in barren areas where the urchins have been cleared, this would ensure optimal recoveries of urchin in the longer term.

Two methods were used to re-initiate *Macrocystis*, these were growth from spores and transplants.

METHOD

Spore release

Macrocystis plants have specialized fronds at the base of the plant that are the source of spores. These fronds are termed sporophylls. Sporophylls were collected from 5 - 10 plants and returned in seawater to the laboratory. To initiate spore release, sporophyll surfaces were wiped clean and placed in a 10% solution of the antiseptic Betadine in seawater for 10 minutes to surface sterilize, rinsed in sterilized seawater, wiped clean again and left in a cool place for 1.5 hours. They were then placed in seawater. Spore release was effected within 1-2 hours.

Spore densities in solution were determined using a graduated microscope slide (haemocytometer). Substrate for settlement were 5mm sections of 25mm PVC pipe. It was believed spores could most easily be transferred and attached in the field using these 'rings'. Spore numbers were calculated to give a density of approximately 1000 gametophytes per 6.25cm^2 of substrate and added to the container. Gametophytes arising from the settled spores were cultured on the 'rings' for one to four weeks before being transferred into the field. This was attempted on four occasions in the autumn-winter period of 1994 and again in 1995 at both Hope IS and Meredith Pt. Autumn-winter was the period of optimum growth of *Macrocystis* plants in SE Tasmania as determined by Sanderson (1990).

Transplants

Macrocystis plants were transplanted as part of this program on four occasions. First to Hope Is and Stapleton Pts. Plants were transplanted to Hope Island to provide a spore source and plants for the urchin/limpet manipulation experiment (see Section 2).

Plants were transplanted to Stapleton rather than Meredith Pt, to optimize the chances of success as a test of the method. Meredith Pt has much fine sediment on the reef surfaces and relatively little water movement, both conditions not usually associated with *Macrocystis* beds. Plants were obtained from Dodges Ferry as this was the site of many juvenile plants at the time; June 1994. Juvenile plants were used in preference to larger plants, as the smaller size made handling easier. Plants were attached to bricks using rubber bands and placed on the reef surface. Urchins were cleared from the immediate vicinity of transplants at Stapleton Pt to prevent possible herbivory from this source. After the success of these operations, tranplants were also later done to Meredith Pt and Oakhampton Bay in the winter of 1995. Plants for these sites came from Southerly Bottom.

RESULTS

Spore release

Results for raising *Macrocystis* plants from spores were mixed. PVC pipes transplanted into the field to Meredith Pt did not give rise to plants.. At Hope Is, not all PVC pipes gave rise to plants and those that did, did so after a time lag of 1-3 months.

Transplants

Plants transplanted to Hope Island and Stapleton Pts have survived well. At Hope Is there was highly significantly better survival in squares that had been cleared of urchins (see Section 2). At both sites, the most marked change was observed the year after the transplants had been initiated. The plants that had been placed into the sites released spores resulting in many new plants in the following year.

The plants placed at Meredith Pt in 1995 have survived into 1996, but do not appear healthy with faded lamina, little growth and much fine silt on their surfaces. There has been high mortaility of the plants at Oakhampton, with only three survivors observed in early 1996. Loss of plants is believed to have been due to swells experienced in the area.

DISCUSSION

It was concluded that more research needs to be done into using spores to re-initiate plants. The mixed results experienced was most likely due to the conditions into which the cultivated spores had been placed and success will be seasonally determined.

Transplants were successful and also served as a good source for future plants.

SECTION 6: AGING

INTRODUCTION

Aging of the urchins is a valuable tool to enable calculation of growth rates, recruitment and mortality rates from population size structures and yield per recruit analysis.

Three methods of aging the urchins were attempted.

1/ counting of ridges on teeth and validation through marginal increment analysis

2/ Tetracycline tagging

3/ monitoring age classes through regular size frequency analysis.

RIDGES AND MARGINAL INCREMENT ANALYSIS

Method

If ridges are laid regularly, such as once per year, then the distance from the most recent ridge to the aboral end of the tooth should also vary regularly. Each month, as part of the gonad-sampling program, 25 (-50) urchins were collected from both sites. Distance from the most distal ridge to the end of the tooth was recorded, as well as the number of ridges, distances between successive ridges and length of the tooth (see Fig. 6.1).

Teeth were processed as follows:

- Aristotles Lantern was removed from harvested urchins and stored in numbered seedling trays.
- Lanterns were soaked for 24 to 78 hours in a 0.1 - 0.5 % (w/v) chlorine solution made using Olin HTH Granular Pool Chlorine (active ingredient 655g/kg CaOCl).
- Jawbones were separated and remnant soft tissue was removed by brushing with a soft bristled tooth brush. Washed jawbones were soaked in chlorine for another hour then rinsed with water and air dried.
- Observations of annual ridges on urchin jawbones were made using a Wild Heerbrugg M5 microscope at 12X magnification with a 0.3X adaptor lense attached. A Sony model DXC 151Ap colour video camera was used to capture images which were analysed on a Macintosh Quadra 650 computer using the National Institute of Health, USA image analysis package " NIH Image, version 1.57". Measurements were calibrated against a stage micrometer.

using this method but came from a barren. These urchins also have a poor fit for the estimation. There was only a relatively narrow size range for these urchins which reduces the confidence of the fit.

TABLE 6.1 Estimation of growth parameters from fitted Von Bertanlanffy growth curves using one ridge as equivalent to one year's growth. K is the growth constant and L_∞ is the estimated maximum diameter.

SITE	K	LINF	r^2(raw)	r^2(corrected)	N
Deep Hole	0.552	71.757	0.984	0.163	89
Dennes Pt (20')	0.322	75.541	0.973	0.24	100
Dennes Pt (65')	0.704	73.294	0.983	0.304	50
Hope Is 1D	0.389	92.887	0.99	0.308	367
Hope Is 8S	0.358	77.432	0.986	0.298	216
Hope - tetracycline	0.614	64.412	0.993	0.057	59
Horseshoe Reef	0.222	50.587	0.977	0.202	16
Huon Pt	0.441	102.753	0.987	0.108	80
King Is (Chris Is)	0.519	81.506	0.988	0.095	28
King Is (Counc Is)	0.481	78.207	0.993	0.299	48
King Is 2.1	0.468	78.349	0.987	0.048	25
King Is, Grassy 1	0.466	82.229	0.997	0.275	27
King Is, Grassy 2	0.226	100.892	0.991	0.461	24
Long Bay	0.284	85.133	0.96	0.237	97
Meredith 5S	0.553	74.786	0.988	0.348	389
Meredith - tetracycline	0.359	82.561	0.986	0.382	85
Oakhampton	0.268	84.96	0.986	0.525	100
Safety Cove	0.509	75.97	0.993	0.408	74
Stapleton	0.182	85.985	0.966	0.449	83
MEAN	0.42	79.96			1957

TETRACYCLINE

Method

At both Meredith and Hope Island, four concrete-filled tyres were used to mark out the corners of a 10 X 10 m^2 square. All urchins within these squares were injected in-situ with a lg Tetracycline HCl (Sigma) per 100 ml filtered seawater solution at the rate of 0.1 ml per 10 g body weight (converted to diameter equivalent) in February 1994 (as per Ebert 1982). In February 1996 all urchins were harvested from within the square and their teeth processed as above. Use of a UV light showed which urchin teeth had taken up the tetracycline tag. These teeth were analysed using image analysis apparatus (as above). Colour scanning gave an image that coould be split into blue, green and red components. Examination of the blue section of the image revealed the tetracyline markings as per Fig. 6.6. The distance was measured from the aboral end of the tooth to the tetracycline mark and other measurements taken as above. Von Bertanlanffy growth curve parameters were calculated from Walford plots as per Ebert (1980a).

Results

At Meredith Pt, 41 of the 164 urchins collected had the tetracycline tag (25%), while at Hope Island, 59 of 300 collected were tagged (20%). Fig 6.7 shows Walford plots for the data and resulting Von Bertanlanffy growth curves with confidence intervals. In 6.10 c the different methods have been compared on the one graph. The tetracycline results estimate consistantly slower growth than if using the ridges at either one per year or two per year.

Table 6.2

Growth rate parameters estimated using Walford plots as per Ebert (1980a).

SITE	K	LINF
Meredith Pt	0.20	84.99
Hope Is	0.21	64.09

SIZE FREQUENCY ANALYSIS

Method

Modal progression anlysis was conducted within the squares at Meredith with size frequencies measured every six months. There were no clear progression of nodes (Appendix 2). In the summer of 1993, the heaviest rainfall experienced for 25 years occurred on the east coast of Tasmania (Fig. 2.10). Many mortalities were noted on the Meredith site in water less than 1.8m deep. Nearby in the port of Triabunna, a reef called Horseshoe Reef by the divers experienced mass mortality of urchins. Two years later, we sampled urchins from this reef, believing them to be the Dec-Jan 1993/4 cohort. Size frequencies were sampled regularly.

Results

Size frequencies of urchins from Horseshoe Reef, are presented in Fig 6.8. They show growth of the cohort from approximately 27.5 mm at estimated18 months of age to approximately 39 mm at 30 months. For teeth from urchins sampled at Horseshoe Reef sampled 11 Jan 96, a Von Bertanlanffy growth curve was fitted to ridge-test diameter data assuming one ridge per year The gave a slower growth rate of: 1.5 yr; 14mm, 2.5 yr; 21.5mm. Median number of ridges per tooth was between four and six for the 11 Jan 96 sample. These urchins were believed to be 24 months old. Again results indicate that ridges are not deposited synchronously or that the number of ridges deposited each year is variable making interpretation of ridge data tenuous and complex.

<u>Tooth length to test-diameter ratio</u>

Urchins have shown an ability to shrink their tests at times of low food availability while tooth length stays the same (Constable 1989). The relationship between tooth length and test diameter was examined for a number of populations and is nearly linear (see Fig 6.9). By comparing how each of the populations tooth length to diameter ratio compared to a grand mean;

$$\text{Diameter (mm)} = -1.16 + 5.525 * \text{tooth length (mm)}$$

we can make inferences about food availability to the populations. In fig 6.10 are presented the mean residuals for each of those populations. Sites that are barrens consistantly have a higher tooth length to diameter ratio. Urchins that come from sites that are known to be good recovery areas for urchin roe have lower tooth length to diameter ratios. This opens the possibility that this relationship may be used to determine the potential for roe recovery of populations where conventional sampling is difficult. In Fig 6.11, is the variation in this ratio for the one site over a number of months. As is evident, the ratio remains consistant. the variation that is evident indicates some shrinking of the test while the urchin roes are developing (Fig.s 2.3-2.7).

The tetracyclene labelled urchins gave slow growth rates for both sites. Comparison of the tooth length to diameter ratio for the tetracycle labelled urchins from both sites shows high values (starved) for Hope Island urchins and low for the Meredith teeth indicating good growth. This indicates that the tetracycline results are reasonably representative. Is both samples were starved or vice versa then we might consider the results as extraordinary.

DISCUSSION

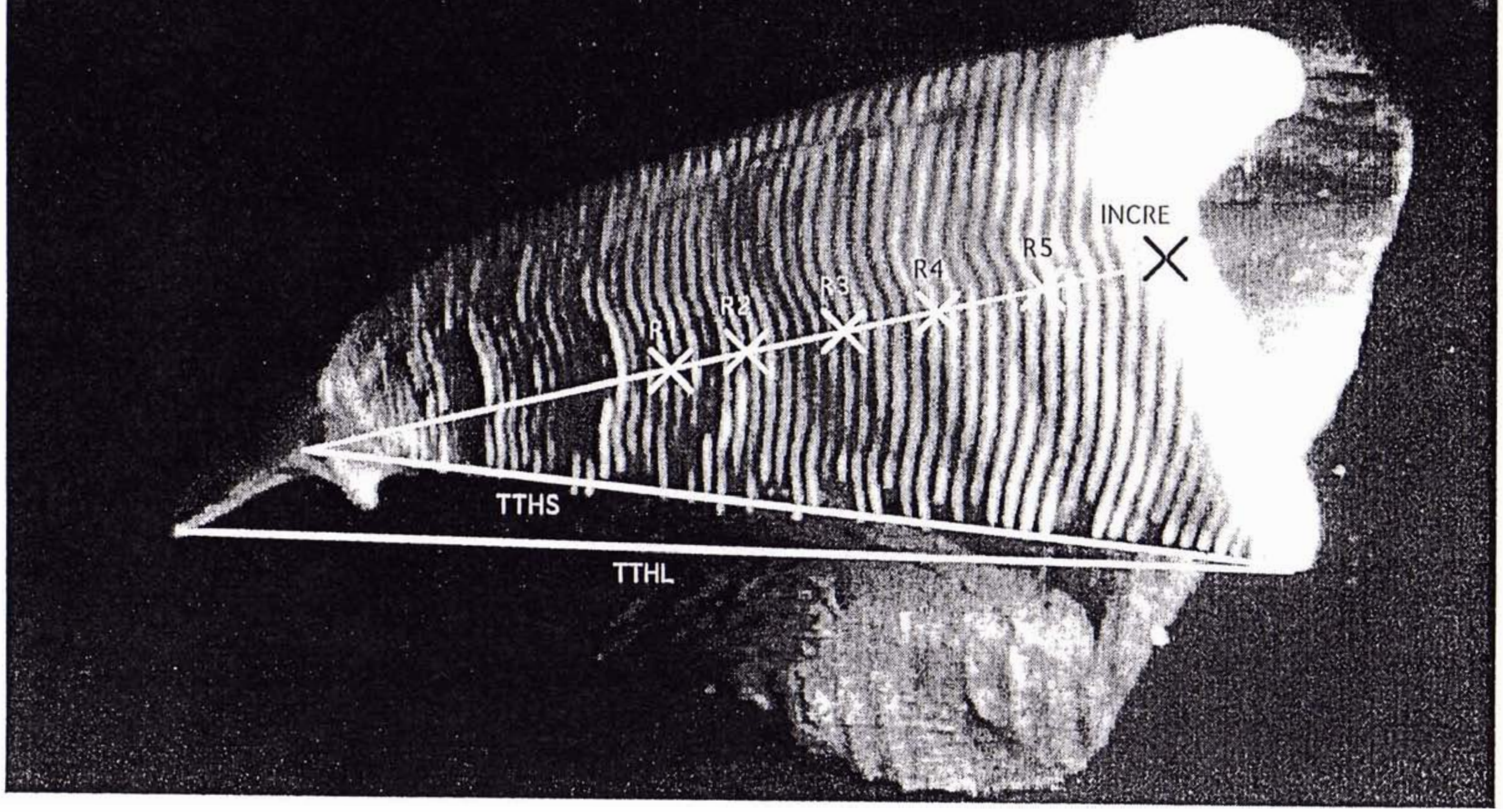
Use of ridges would be the most time effecient method of age determination and only requires one visit to a site whereas the other two methods used here require at least two. Interpretation of aging results using ridges however appears equivocal. There seemed reasonable evidence that the urchins may be forming up to two ridges per year, but the results are not born out by the tetracycline method. The tetracycline results appear representative and show that the urchins are taking a long time to reach maturity. At both the sites, this may be 5-10 years. Further growth rate work needs to be done to clarify this further. Oxygen isotope analysis or microchemistry of the teeth may also be of some help in aging. Monitoring rate of growth of caged urchins, where individuals may be distiguished may be the most direct.

REFERENCES

Constable AJ 1989 An Investigation of Resource Allocation in the Sea Urchin, *Heliocidaris erythrogramma* (Valenciennes). PhD Thesis, Melb Uni.

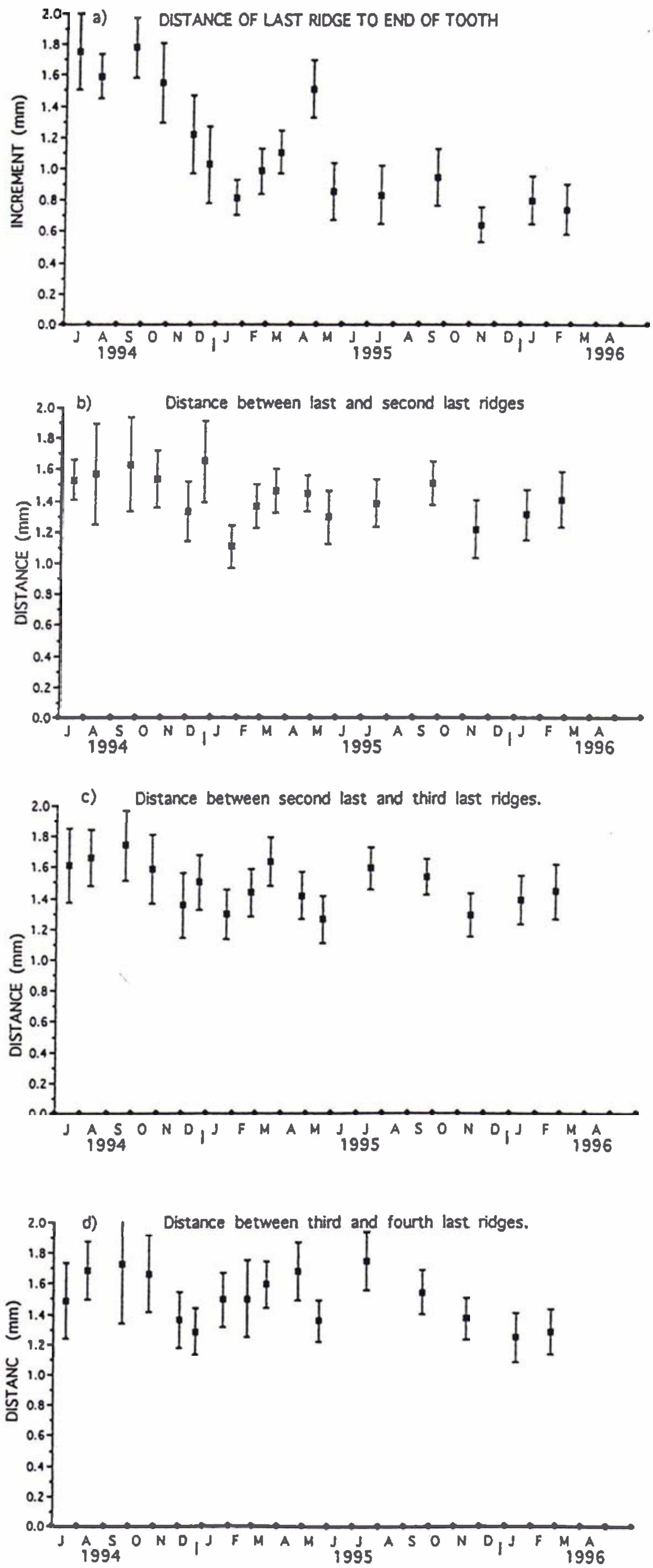
Ebert 1980 a Estimating parameters in a flexible growth equation, the Richards function. Can. J. Fish Aquat Sci, Vol 73, 687-692.

FIGURE 6.1 Diagram showing measurements taken for each of the urchin teeth.



TTHL - Total tooth length
TTHS - Length to 'knuckle'
R1 - Distance to first ridge
R2 - Distance to second ridge
R3 - Distance to third ridge
R4 - Distance to fourth ridge
R5 - Distance to fifth ridge
Rx - Distance to xth ridge where x is the last ridge.
INCRE - distance to tooth edge.
The length difference between Rx and INCRE is the 'marginal increment'.

FIGURE 6.2 details of teeth from Meredith 5S



MEREDITH 5S

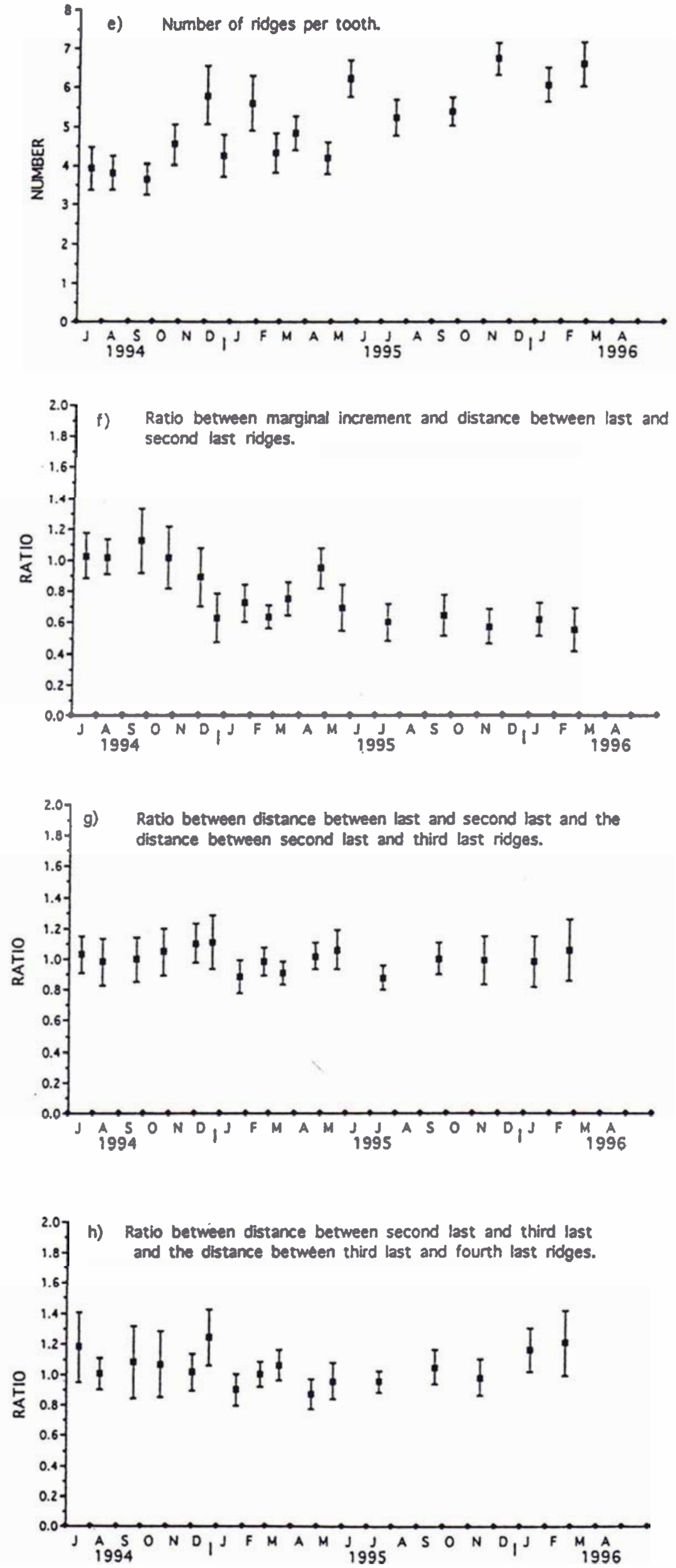
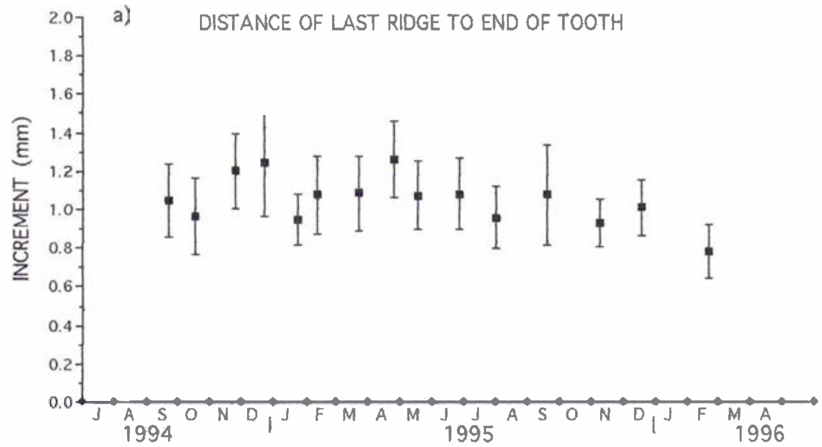
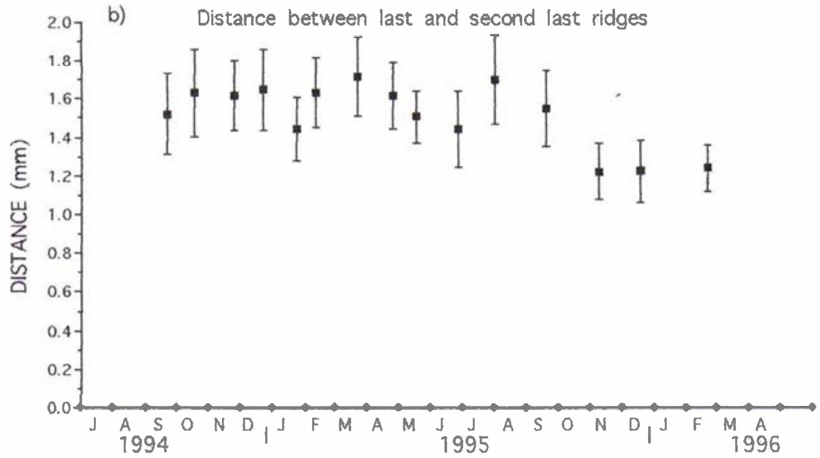
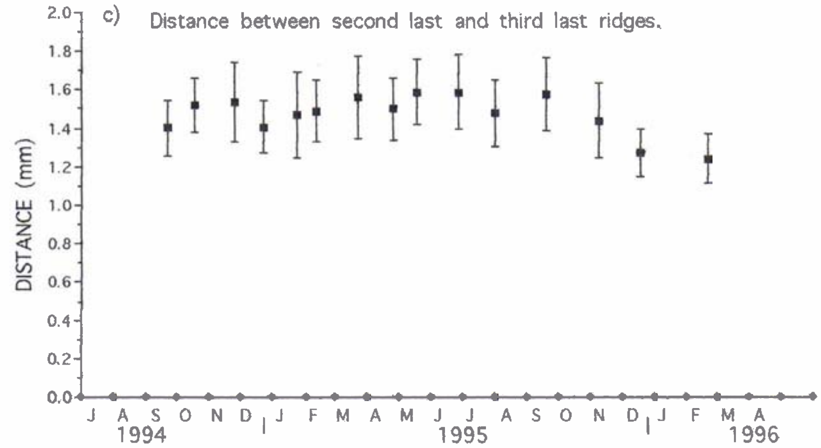
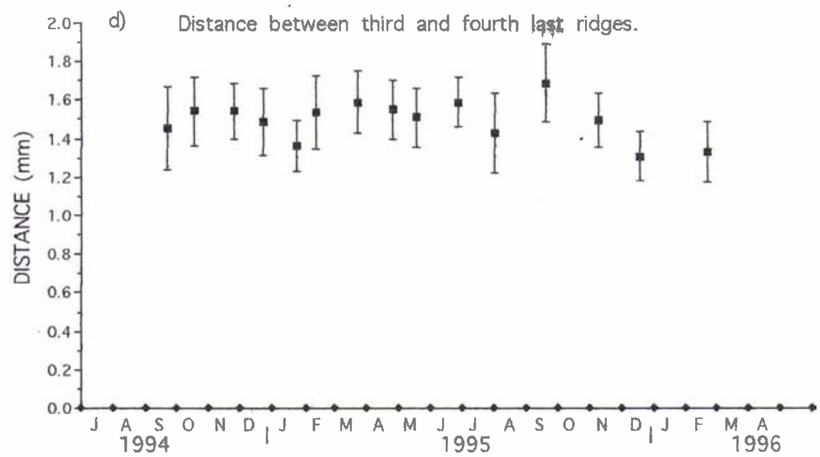

e) Number of ridges per tooth.
NUMBER
f) Ratio between marginal increment and distance between last and second last ridges.
RATIO
g) Ratio between distance between last and second last and the distance between second last and third last ridges.
RATIO
h) Ratio between distance between second last and third last and the distance between third last and fourth last ridges.
RATIO
J A S O N D J F M A M J J A S O N D J F M A
1994
1995
1996

FIGURE 6.3 details of teeth from Hope 1D.

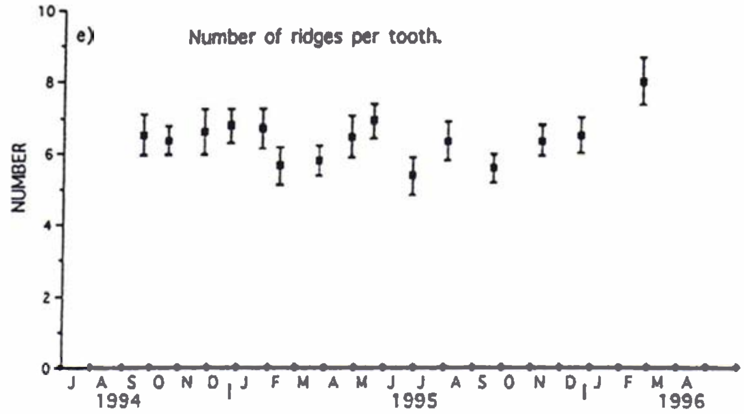


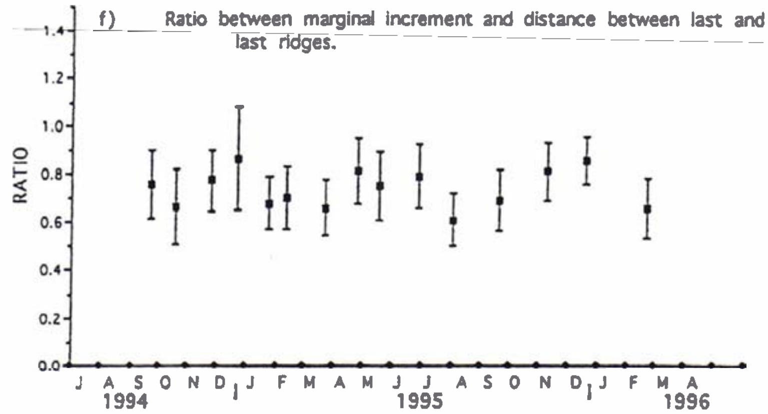


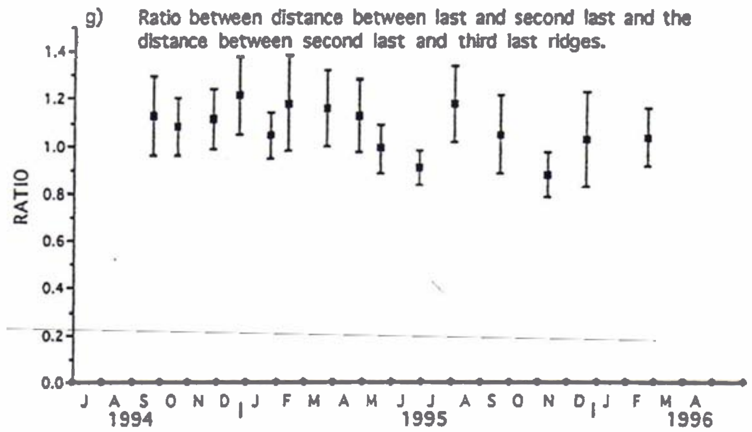




HOPE 1D


e)
Number of ridges per tooth.
NUMBER
0
2
4
6
8
10
J A S O N D J F M A M J J A S O N D J F M A
1994
1995
1996


f)
Ratio between marginal increment and distance between last and last ridges.
RATIO
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
J A S O N D J F M A M J J A S O N D J F M A
1994
1995
1996


g)
Ratio between distance between last and second last and the distance between second last and third last ridges.
RATIO
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
J A S O N D J F M A M J J A S O N D J F M A
1994
1995
1996

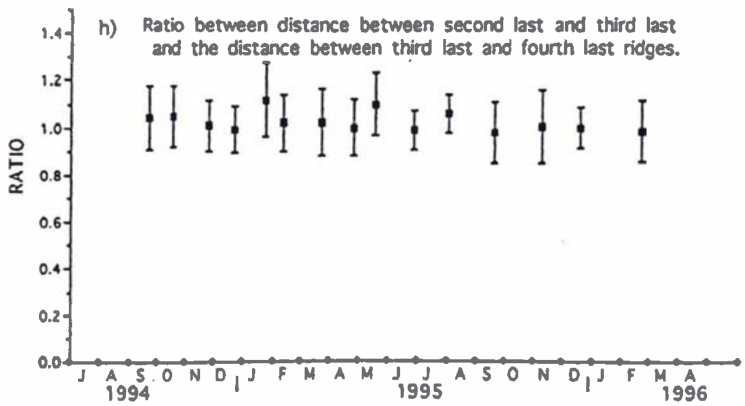
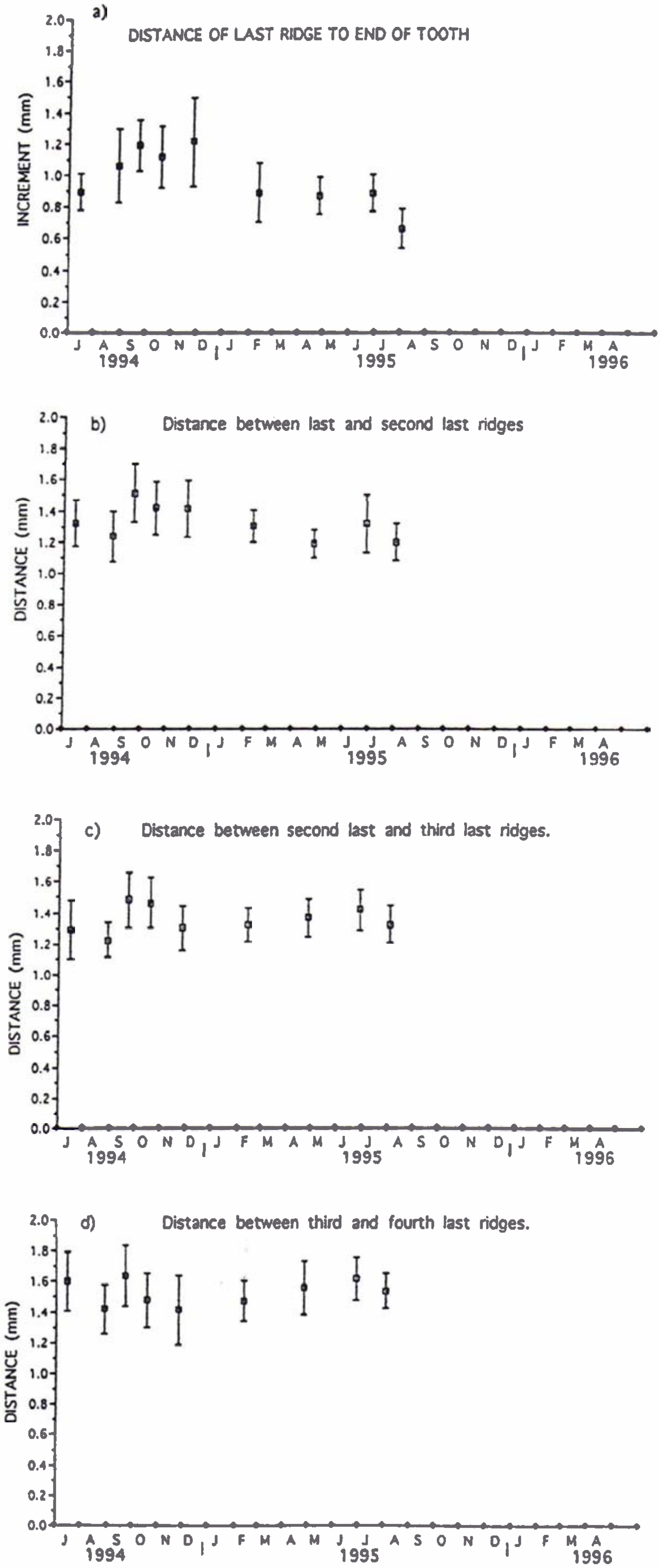
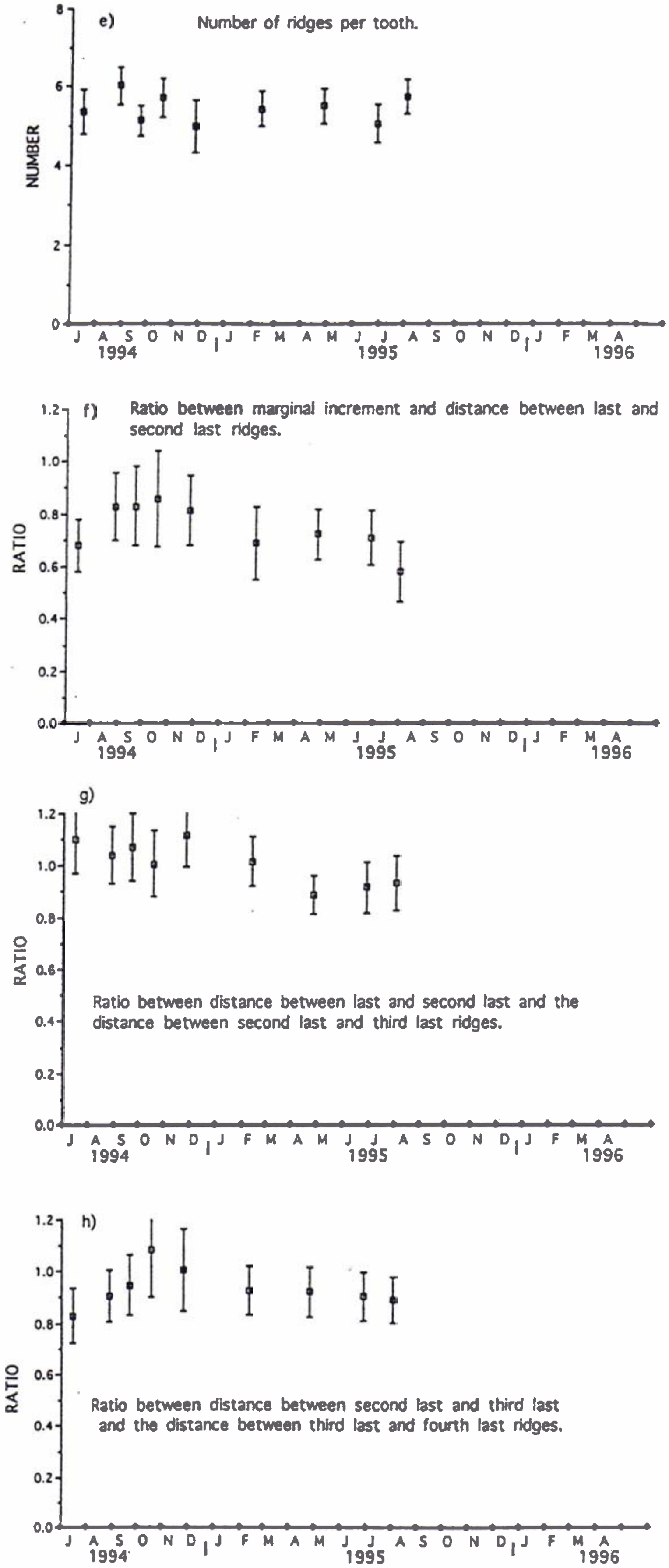

h)
Ratio between distance between second last and third last and the distance between third last and fourth last ridges.
RATIO
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
J A S O N D J F M A M J J A S O N D J F M A
1994
1995
1996

FIGURE 6.4 details of teeth from Hope 8S.



HOPE 8S



e)
Number of ridges per tooth.
NUMBER
J A S O N D J F M A M J J A S O N D J F M A
1994
1995
1996
f)
Ratio between marginal increment and distance between last and second last ridges.
RATIO
g)
Ratio between distance between last and second last and the distance between second last and third last ridges.
h)
Ratio between distance between second last and third last and the distance between third last and fourth last ridges.

FIGURE 6.5 Fitted Brody-Bertanlanfy curves to data assuming one ridge/per year except for top right diagram (two ridges/year).

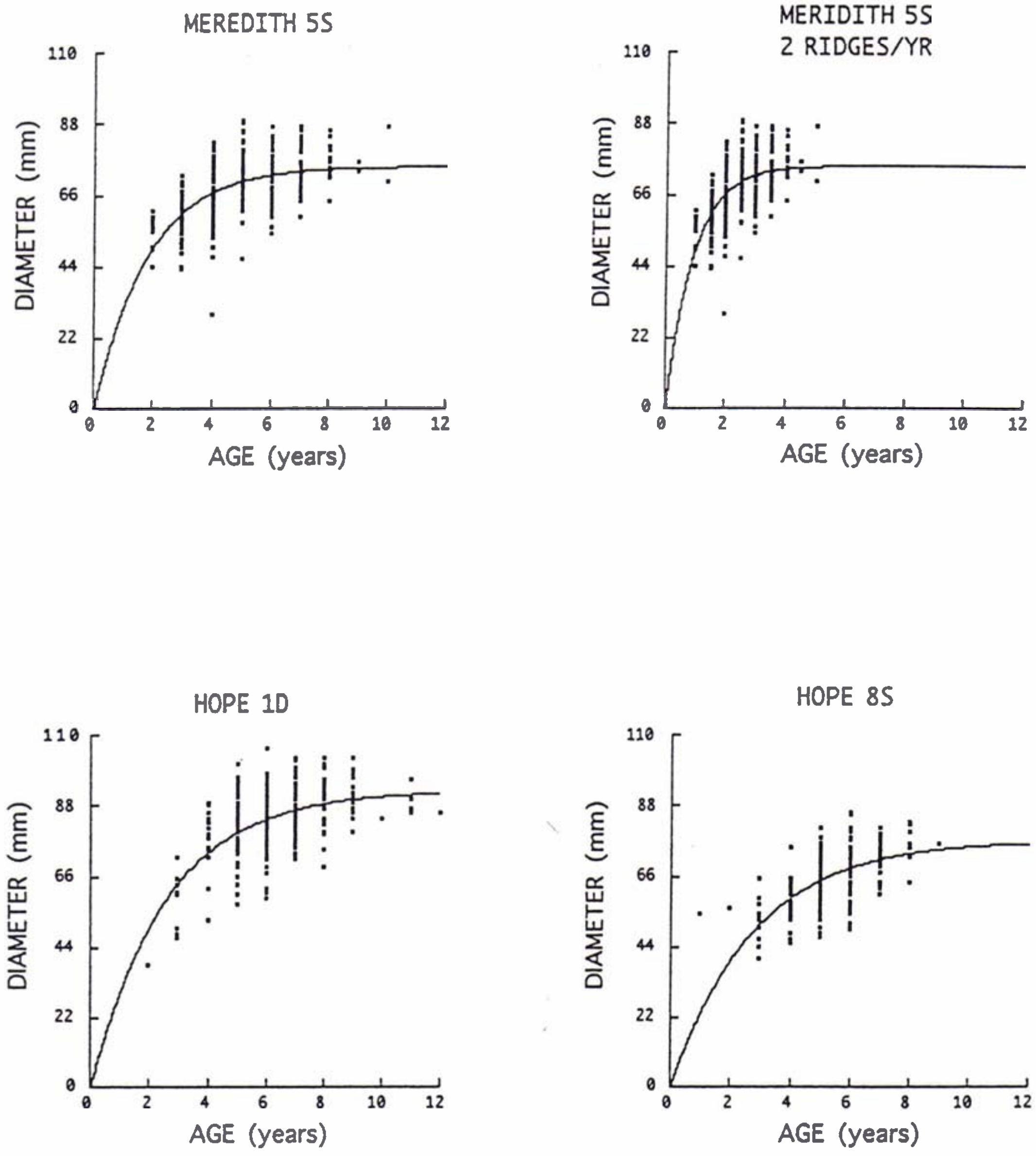


FIGURE 6.9 Tetracycline bands on urchin teeth as evidenced using blue light filters through image analysis apparatus.

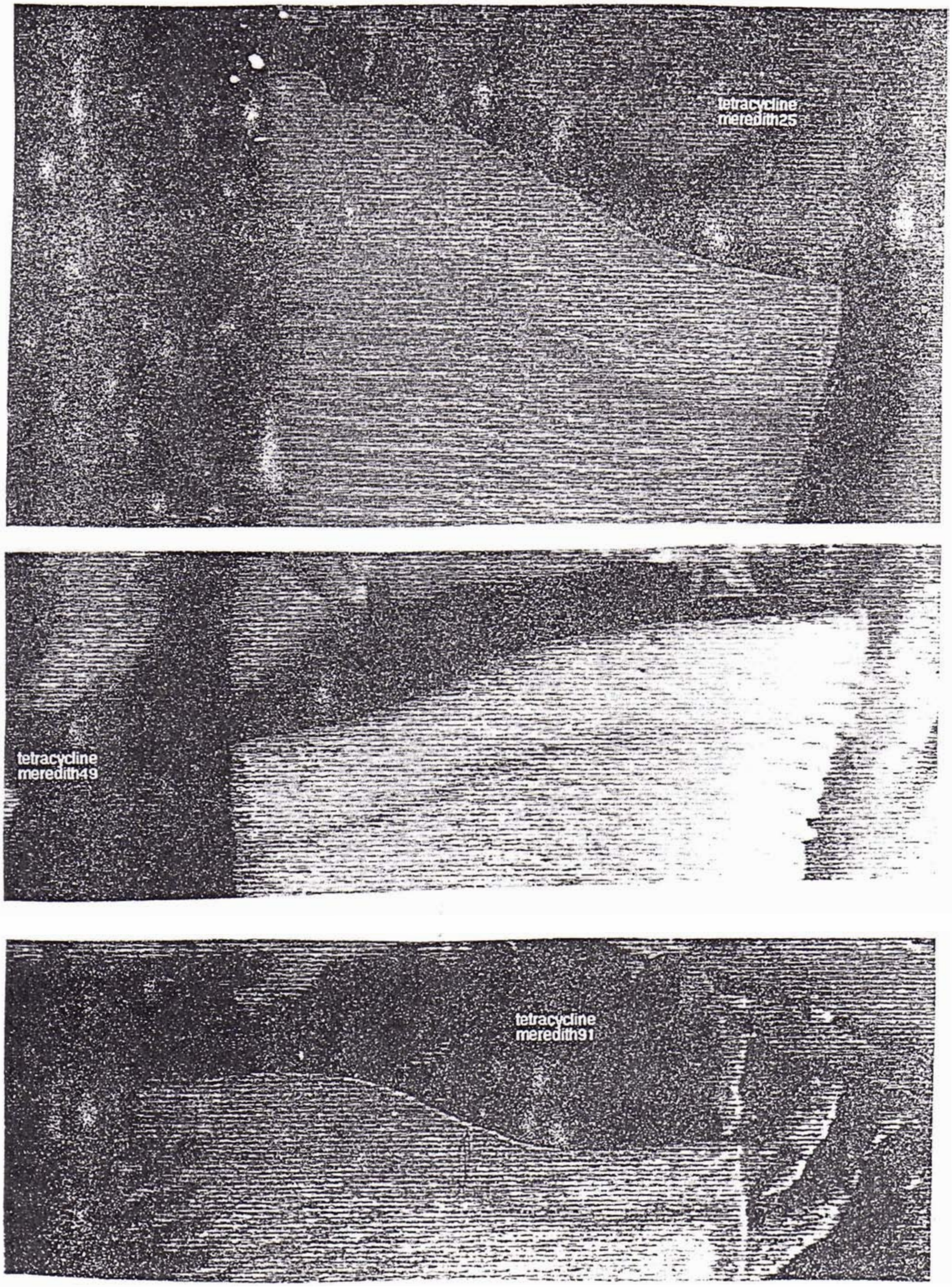
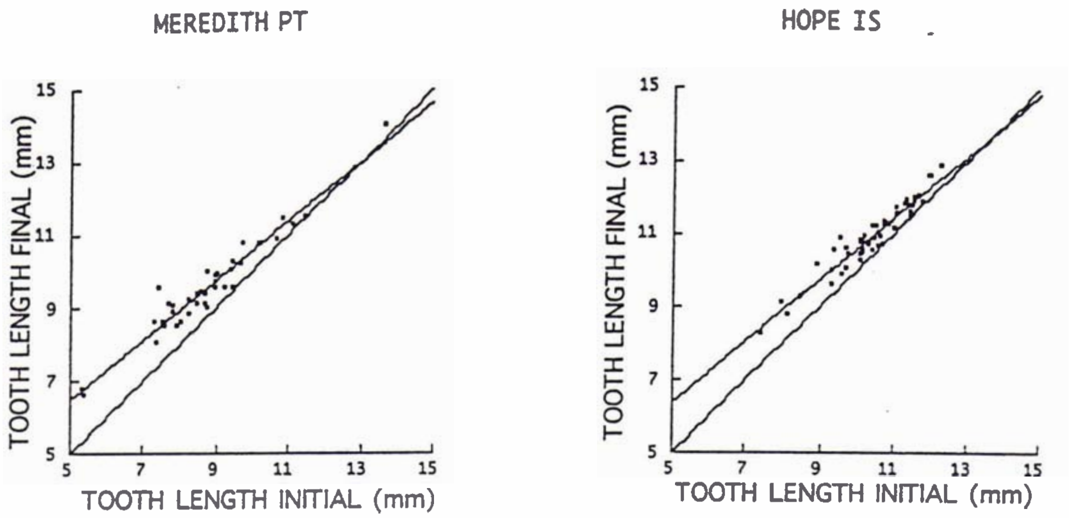
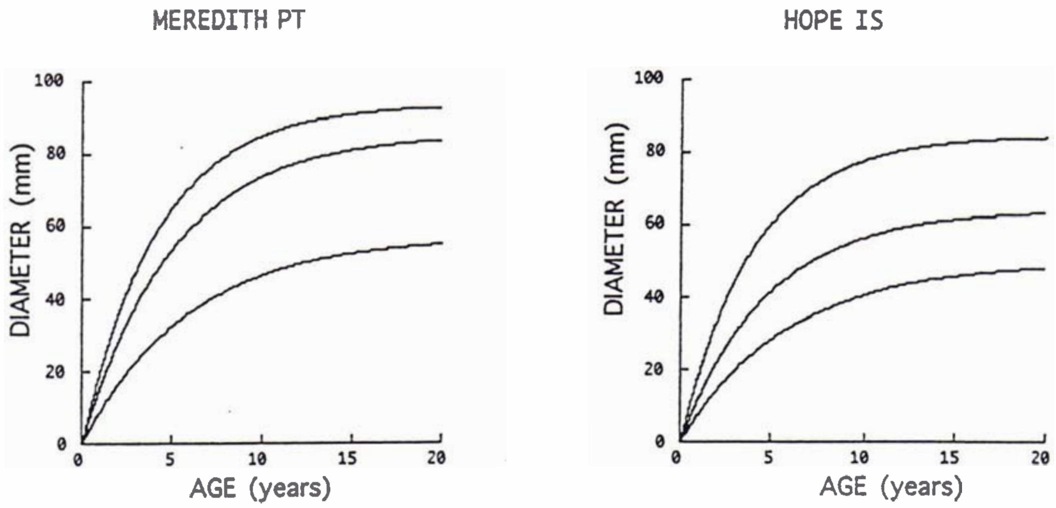


FIGURE 6.7 a) Walford plots for Meredith Point and Hope Island tetracycline labelled urchins



b) Von Bertanlanfy growth curves based on values from Walford plots (+/-se).



c) Comparison of aging estimates on the same teeth, using two and one ridge per year and the tetracycline method.

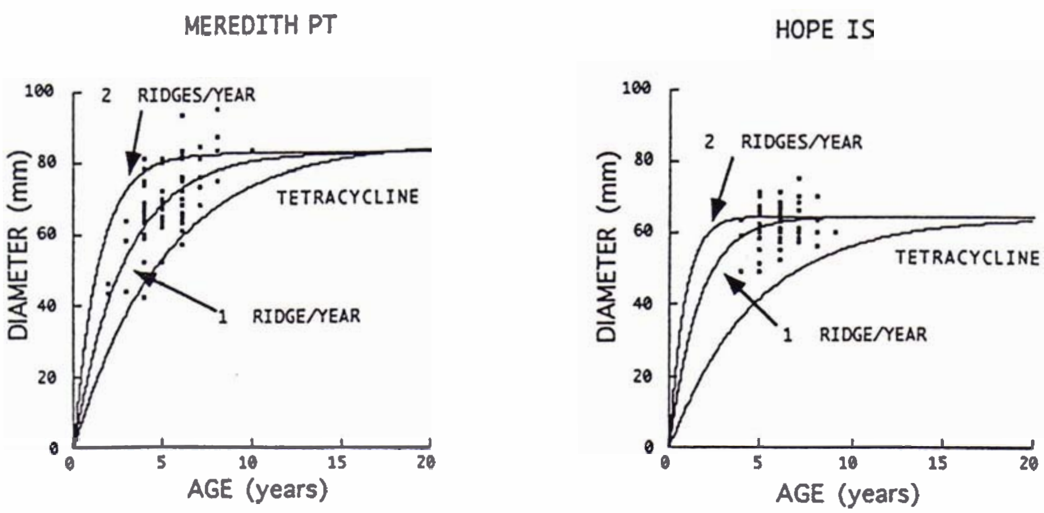


FIGURE 6.8 a-d) Size frequencies of urchins sampled from Horseshoe Reef and e) age (?) frequency of urchins sampled 11/1/96.

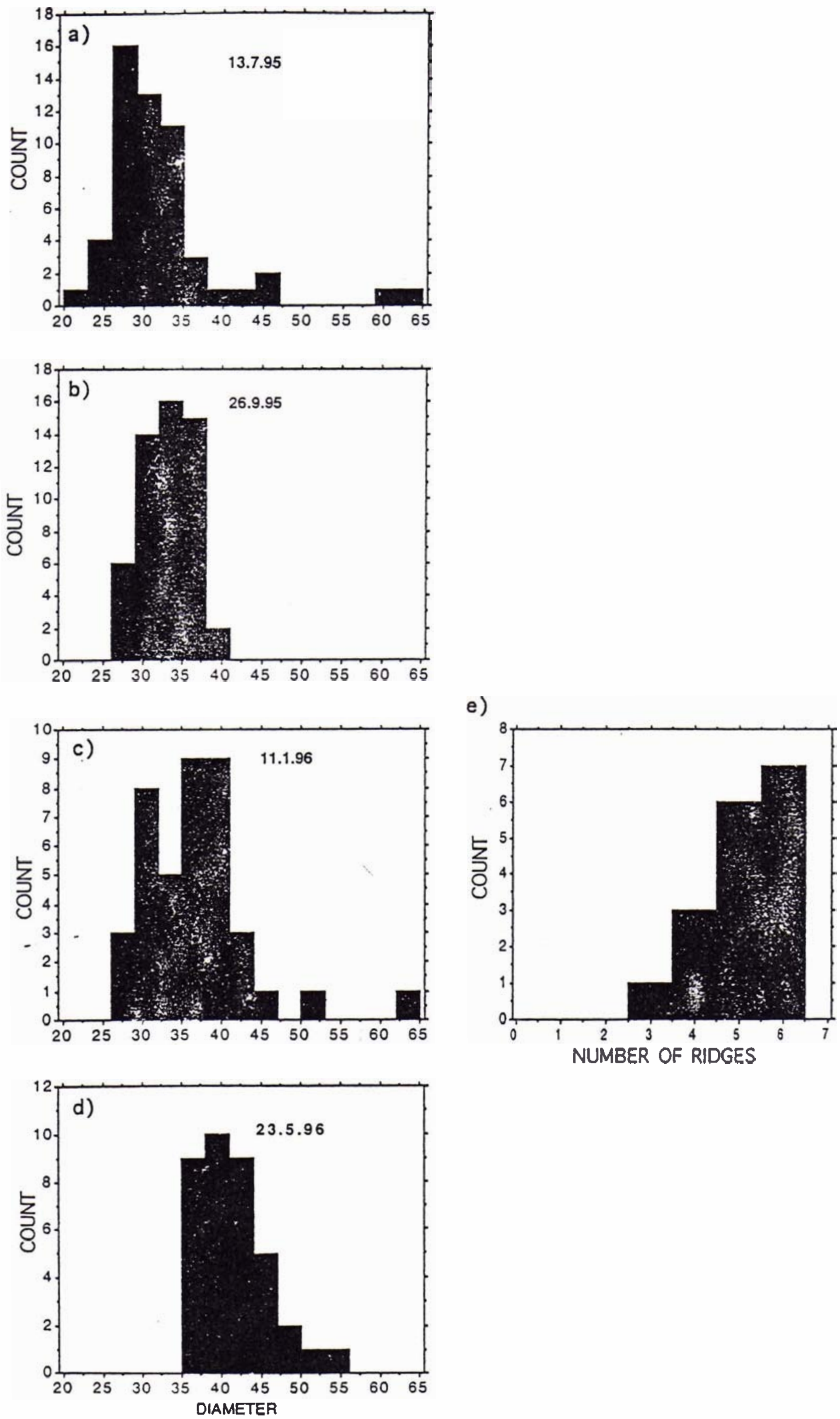


FIGURE 6.9 Relationship between tooth length and test diameter for three sites.

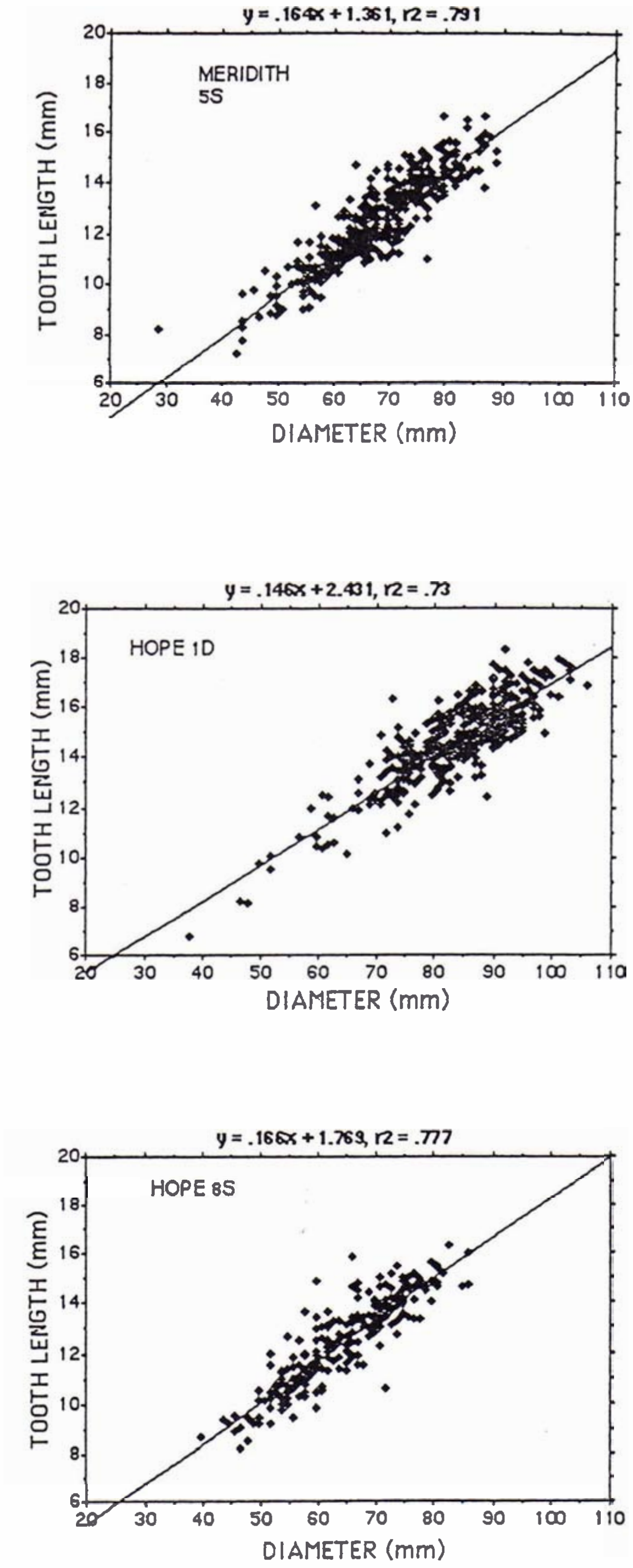
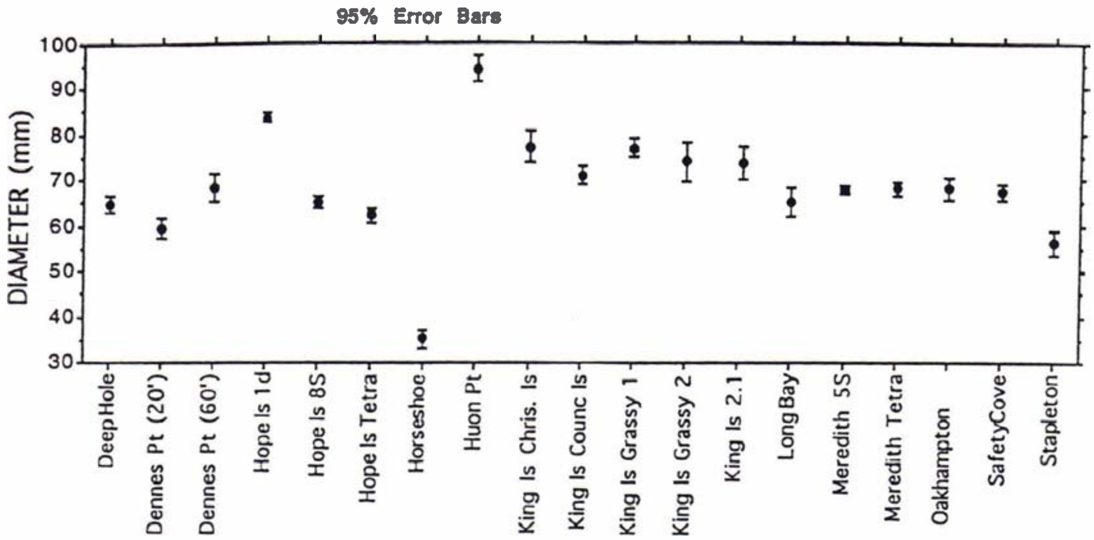


FIGURE 6.10 Mean diameters of aged urchins (above) and mean deviation from overall fitted relationship between tooth length and diameter for each of those populations (* samples from 'barrens').



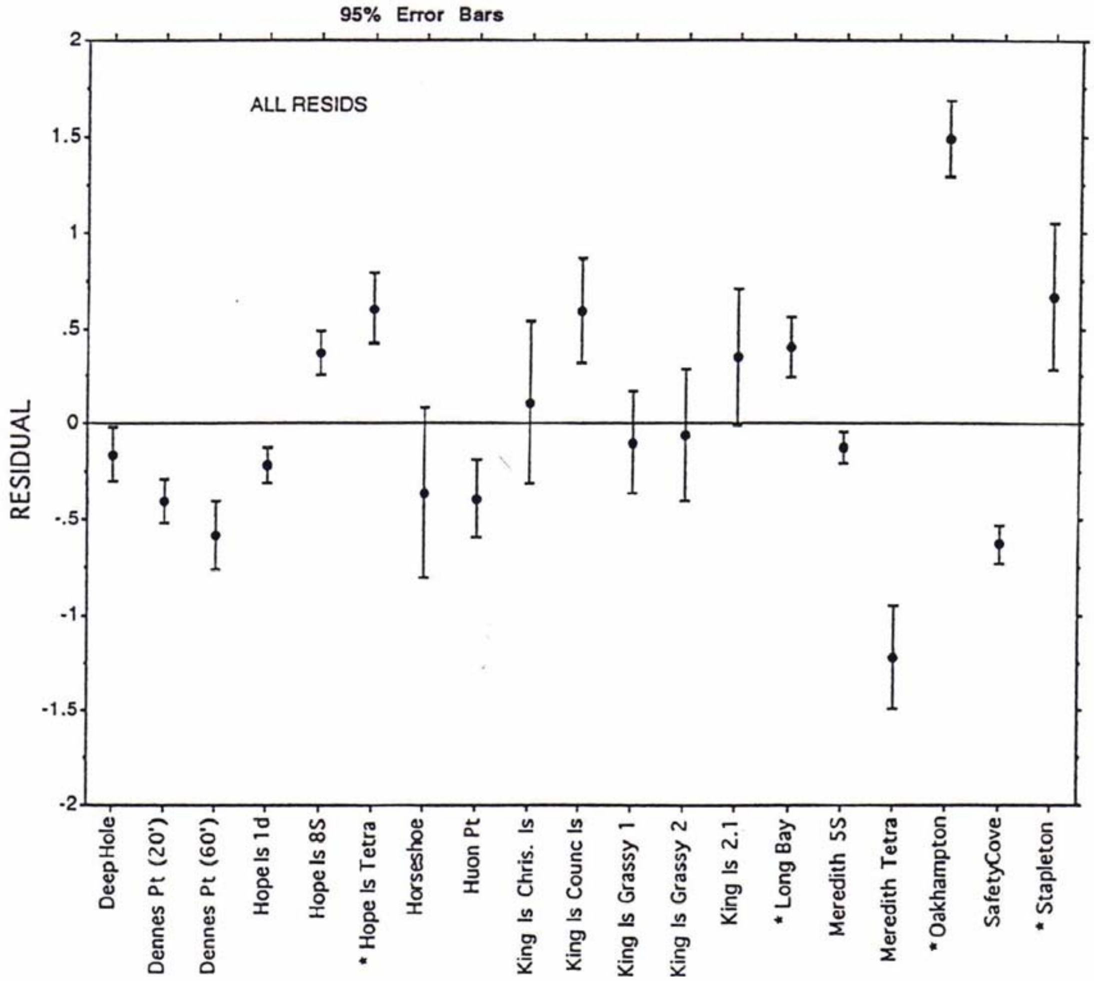
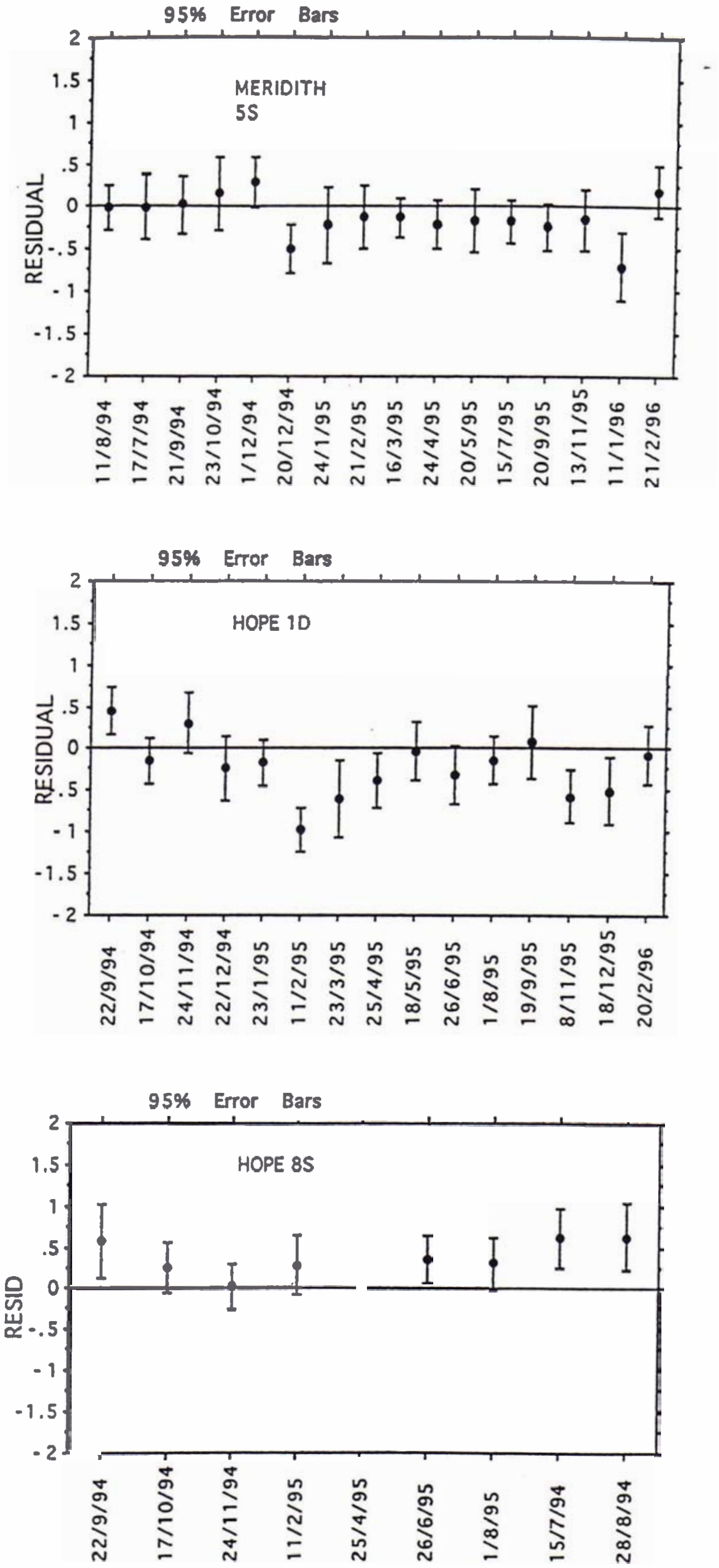


FIGURE 6.11 Mean deviation from overall fitted relationship between tooth length and diameter for each of the three sites: Meredith (5S), Hope Is (1D) and Hope IS (8S) for each sample session.



SECTION 7: MOVEMENT

INTRODUCTION

Movement of the urchins needs to be ascertained to answer one of the assumptions of the manipulation experiments at Meredith Pt. ie. as there are no physical barriers between squares - is there much movement of urchins in or out of these squares - do we need a buffer zone, if so how much? Knowledge of movement of urchins is also necessary in determining how far urchins are likely to move after given time periods for tranplantation and re-seeding exercises. Long term movement of urchins is difficult to determine as they cannot be tagged. The following experiment was designed to circumvent these difficulties.

METHOD

The movement studies were done in two parts. The first examined seasonal changes in movement by checking on movement on a one - two month basis. In the second part, urchin movement was examined over a period of a year.

Part 1

A 10 m x 10 m square was set up at both sites which was cleared regularly (approx. once/month at Hope and once/2 months at Meredith). The corners of the 10 meter square were marked with concrete filled tyres and for each clearing session, a rope grid was set up as per the diagrams in Figs 7.1 and 7.2. At each clearing session, which of the minor partitions within the larger square the urchins came from was noted. The number of urchins within a meter of the perimeter was also noted as movement into the square may be affected by outside concentrations. It was necessary to determine if on-going harvesting might be affecting movement into the square.

This means of estimating movement rate has the advantage of not being directionally biased but as the measurement area becomes smaller towards the inner square, there is likely to be an overestimate of movement as any urchins moving in are concentrated in the middle and this should be taken into account.

Part 2

Early in 1995, the above two squares were not cleared but monitored regularly, approximately once every 3-4 months. An extra square at the two sites was also cleared to improve estimates of overall rates. At the end of one year, all four squares were cleared again and position and size of urchins harvested noted.

Monitoring was conducted by laying the rope grid as above and using a meter stick, numbers of urchins were counted within one meter of the ropes (see Fig 7.5). This gave finer resolution for urchin movement and ensured that fewer urchins were missed.

RESULTS

Part 1

In Figs 7.1-7.2, the size frequency of cleared urchins from the "outer-outer", "outer" and "inner" areas of the squares demonstrate obvious differences. The "inner" square at Hope Is has a much greater proportion of urchins below 50mm, while at Meredith, there is a higher proportion of urchins below 60mm in the "inner" square. Interestingly, these sizes are those of sexual maturity for these sites (see fig 2.1). It is postulated that the smaller urchins may be the new recruits. Consequently in figs 7.3-7.4 they have been considered seperately in the analyses. An alternative explanation may be that the smaller urchins move a lot more than the larger urchins, this is unlikely, but should be proved/disproved experimentally.

From the graphs it is apparent that there is seasonal movement of the urchins with more movement occurring from March to August at Hope Is and December to June at Meredith.

Part 2

The densities of urchins as determined from the interim surveys and the final clearance for the four squares are shown in Fig 7.5. These results agree with the results of Part 1 ie. that most movement occurs in the first few months of the year. The change in density from the "outer-outer" to the inner square are represented well by a linear relation (Fig 7.6) . The mean of these linear relationships is significantly different for the two sites with lower movement at Meredith Pt. This agrees with the topography of the two sites as at Hope Is, there is largely a homogeneous reef bottom consisting of small boulders and rocks overlaying a reef base. At Meredith Pt, sand is dispersed around rock outcrops.

Size frequency of the cleared urchins do not show much difference for the Hope Is squares (Fig 7.7) between inner and outer areas as might be expeced from the greater recorded movement and consequent mixing. At Meredith (Fig 7.8), where movement was not as great, there is a higher proportion of the smaller urchins in the inner squares.

DISCUSSION

Relatively little movement was demonstrated over the period of a year at the Meredith Pt site. Our assumption of minimal movement for the manipulations at Meredith was thus met. Topography and homogeniety of the reef bottom may be a significant factor in determining the amount of movement when comparing movement between sites. Movement at Hope Island was much greater than at Meredith and the above assumption could not have been met at this site. Further evidence of minimal movement was the obvious increase in vegetation right up to the border's edge in plots that had been cleared of urchins one-two years after clearance and the localized barrens patches that occurred around tranplanted urchins that had been dumped at the Meredith Pt site after similar periods of time.

TABLE 7.1 Recruitment of urchins believed to be new to the fishery based on the number of smaller urchins harvested from inner squares at both sites.

MEREDITH POINT (<63mm diam.)

	Feb 94 - Feb 95	May 94- May 95	May 95 - Apr 96
Square 1	64	38	24
Square 2			4

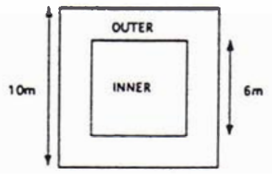
HOPE ISLAND (<51mm diam.)

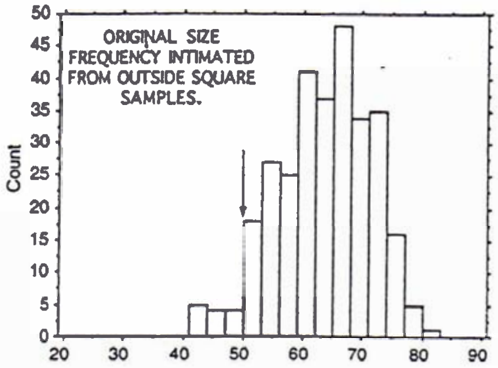
	Jan 94 - Jan 95	May 94 - May 95	May 95 - Apr 96
Square 1	48	37	14
Square 2			2
Year Averages:	56	37.5	11
Overall Average ($/36m^2$)			34.8
Overall Average ($/m^2$)		0.97	

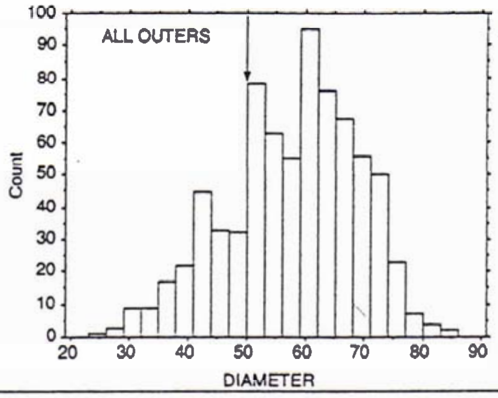
FIGURE 7.1

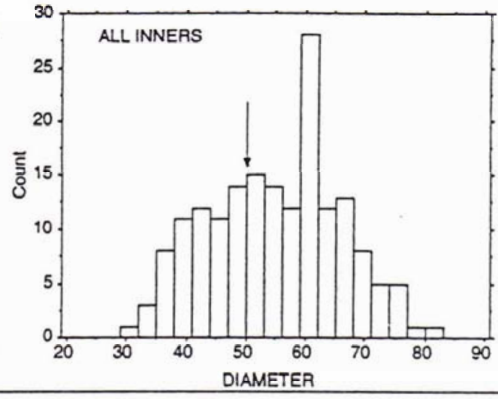
HOPE ISLAND

Size breakdown of **all** urchins harvested from the Hope Is square after initial two clearances (two clearances were required initially to ensure proper eradication of urchins).









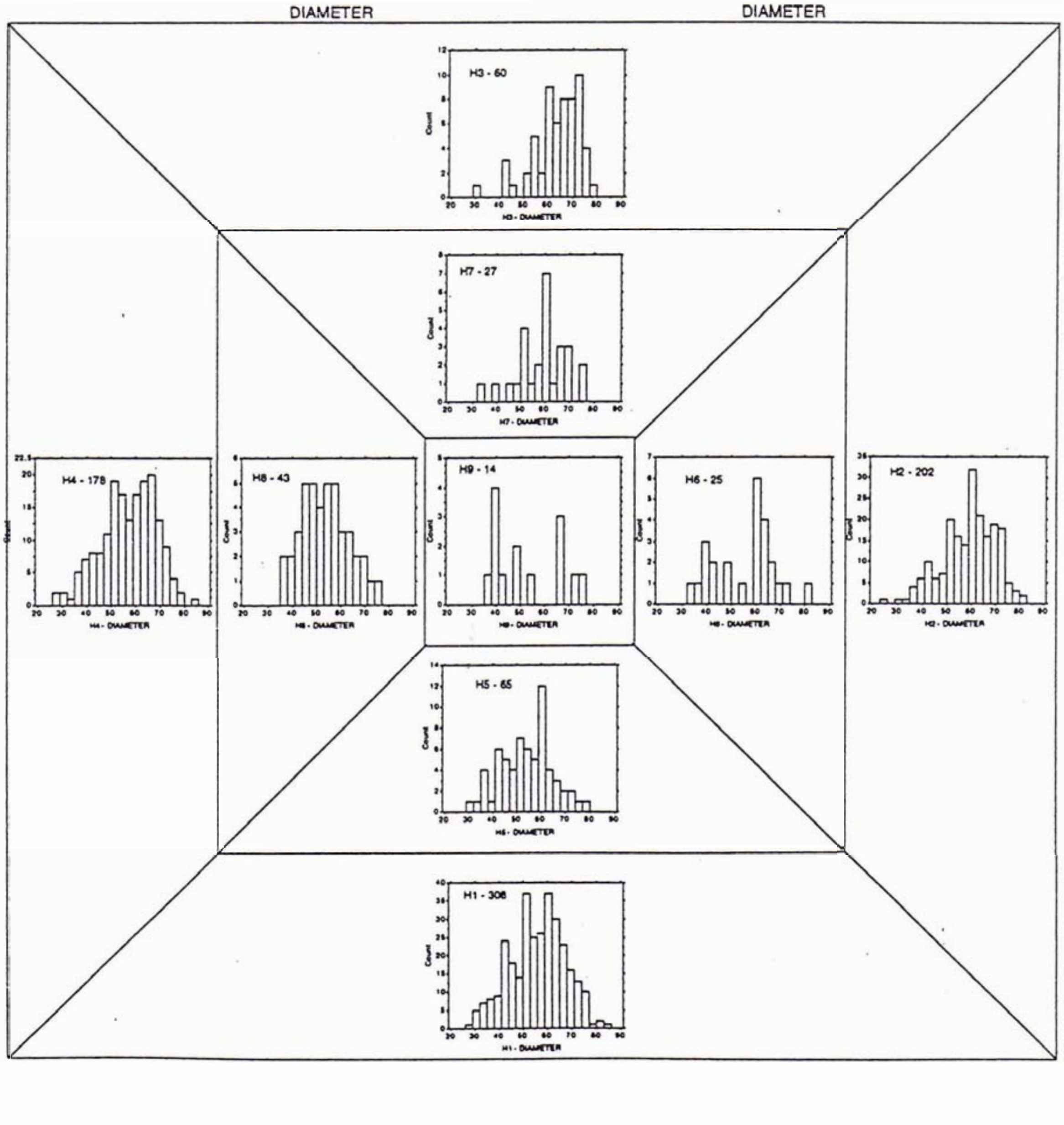
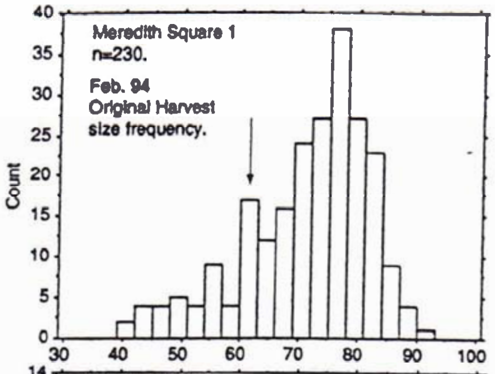
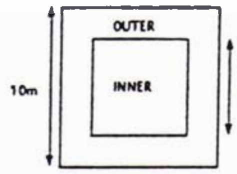


FIGURE 7.2

MEREDITH PT

Size breakdown of <u>all</u> urchins harvested from the Meredith Pt square after initial two clearances (two clearances were required initially to ensure proper eradication of urchins).





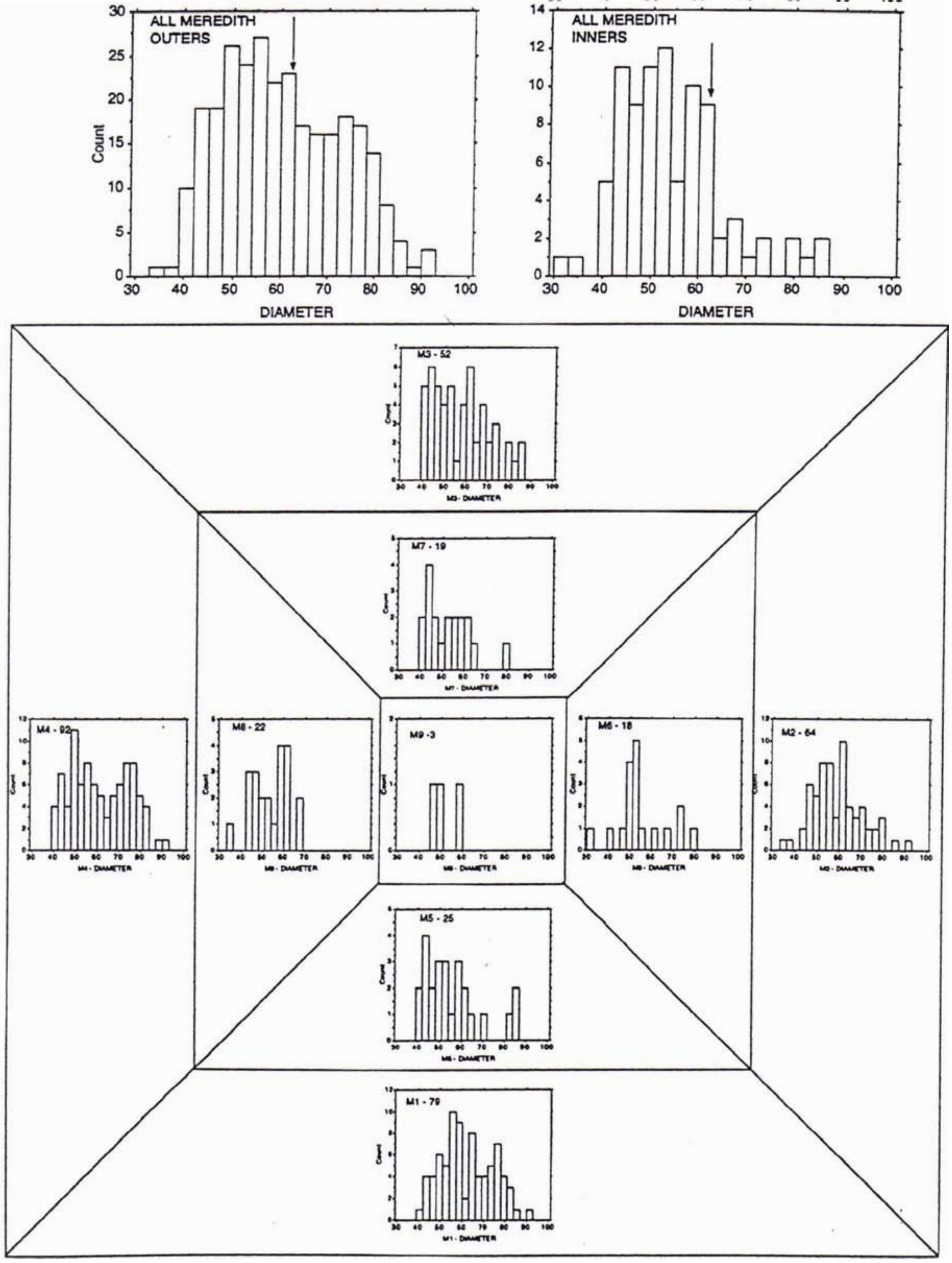
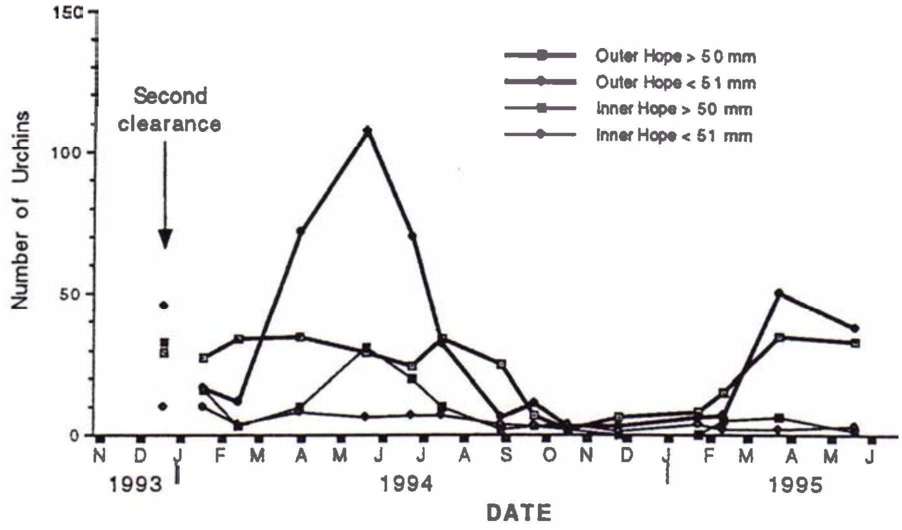


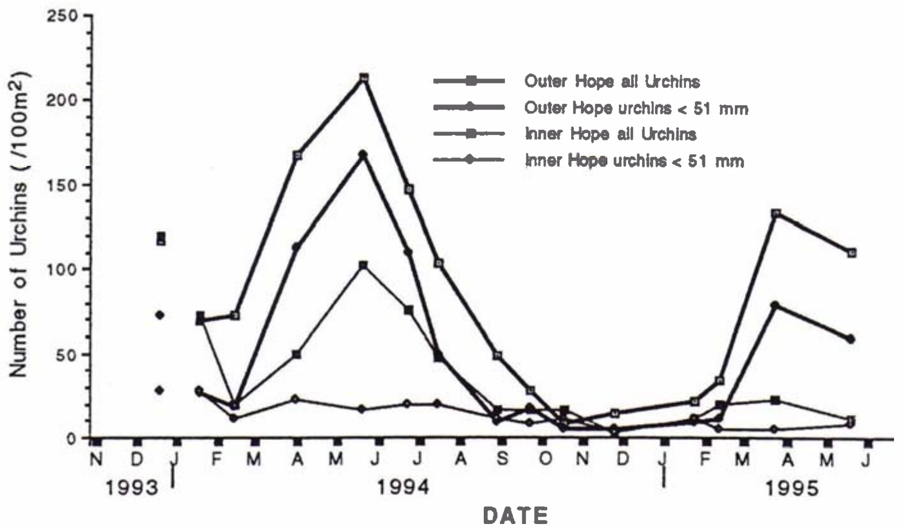
FIGURE 7.3

HOPE ISLAND (50 mm limit)

Urchins harvested from inner and outer square, Hope Is.



Urchin densities in inner and outer square at each harvesting session.



Rate of change in urchin desities at each harvesting session.

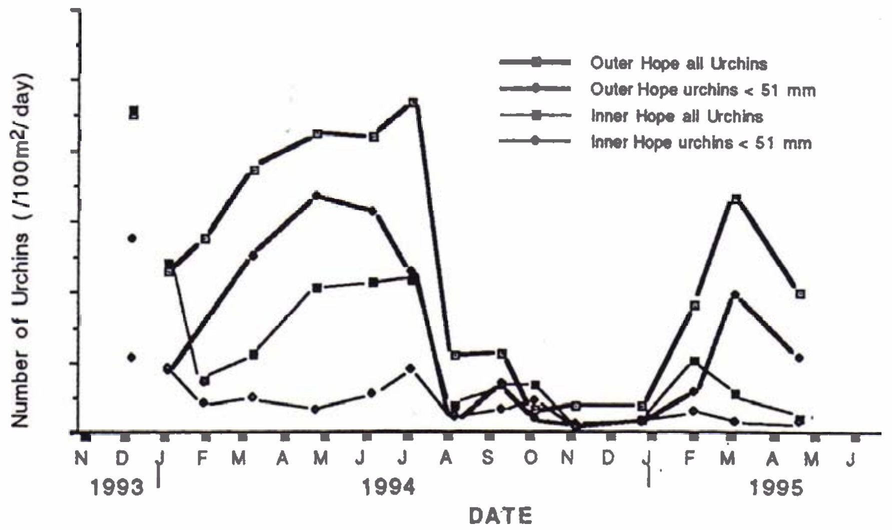
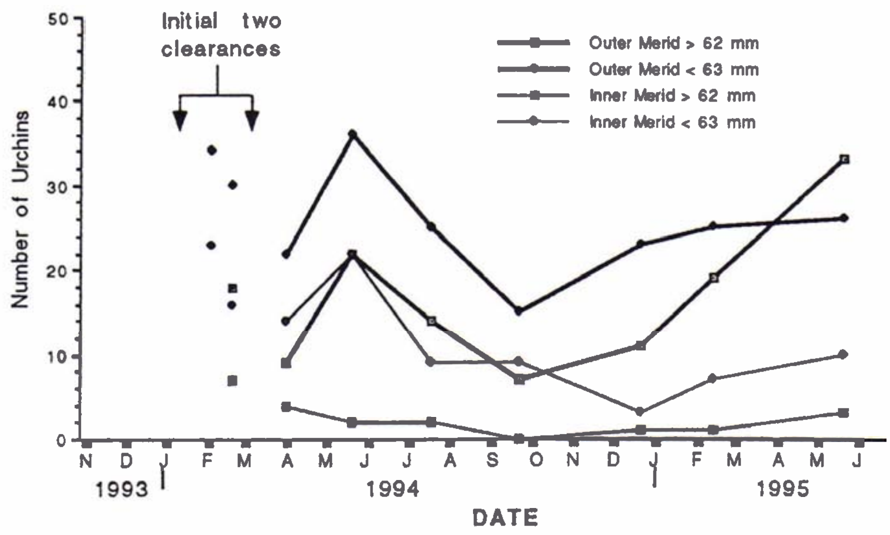


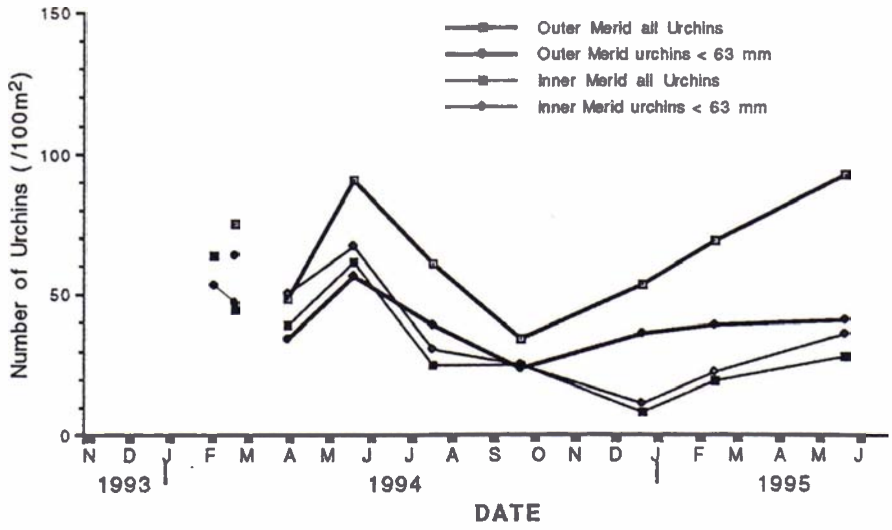
FIGURE 7.4

MEREDITH PT (62 mm limit)

Urchins harvested from inner and outer square, Meredith Pt.



Urchin densities in inner and outer square at each harvesting session.



Rate of change in urchin desities at each harvesting session.

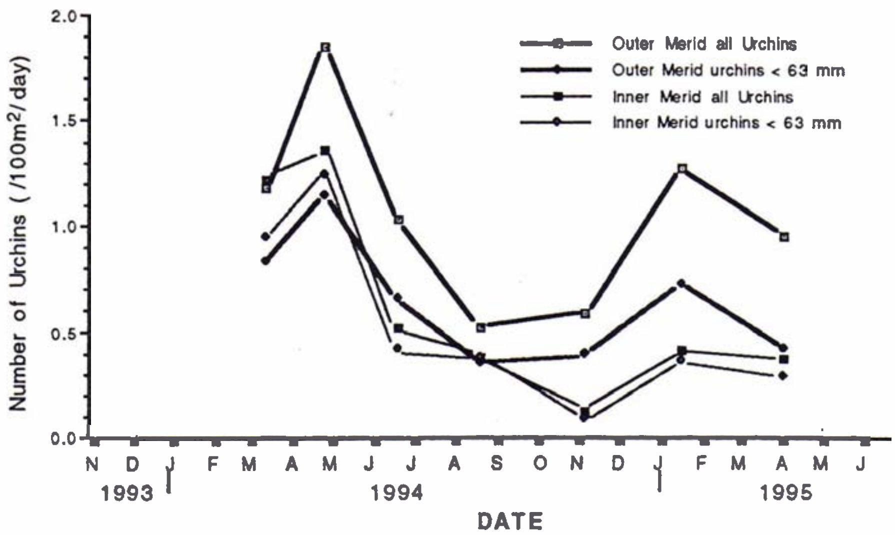


FIGURE 7.5 Density of urchins at differing distances from the edge of the square for the surveys at the end of each quarter of the year, all squares combined.

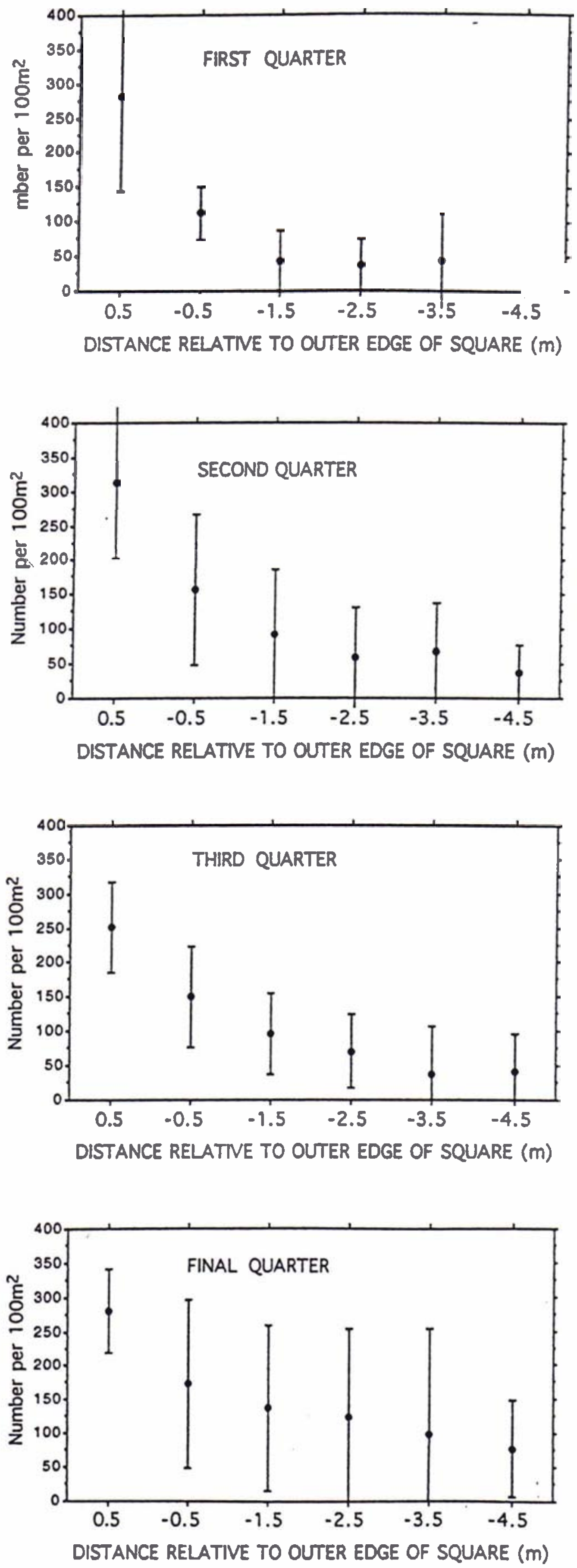


FIGURE 7.6 Decrease in density towards the inside of the square (as a percentage of outside densities) one year after clearance for both squares at both sites.

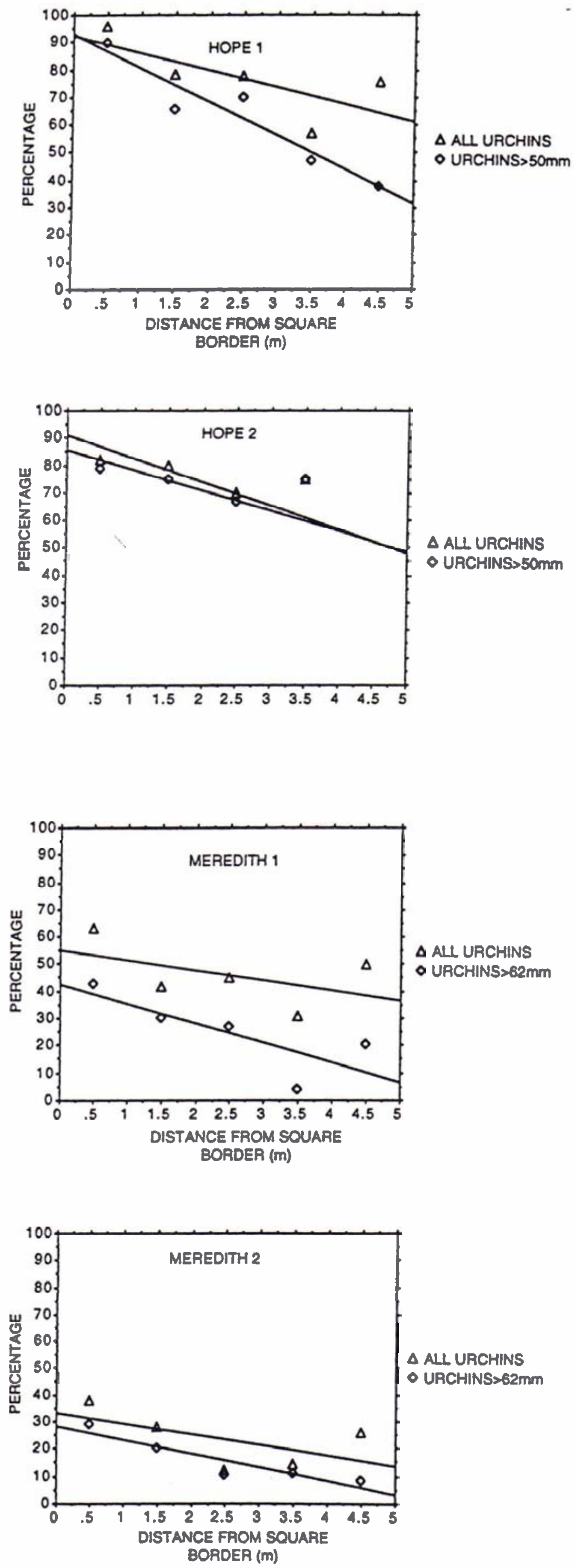


FIGURE 7.7 Size frequency of urchins found before clearances and immediately outside, in the 'outer' and 'inner' one year after clearances for both squares at Hope Is.

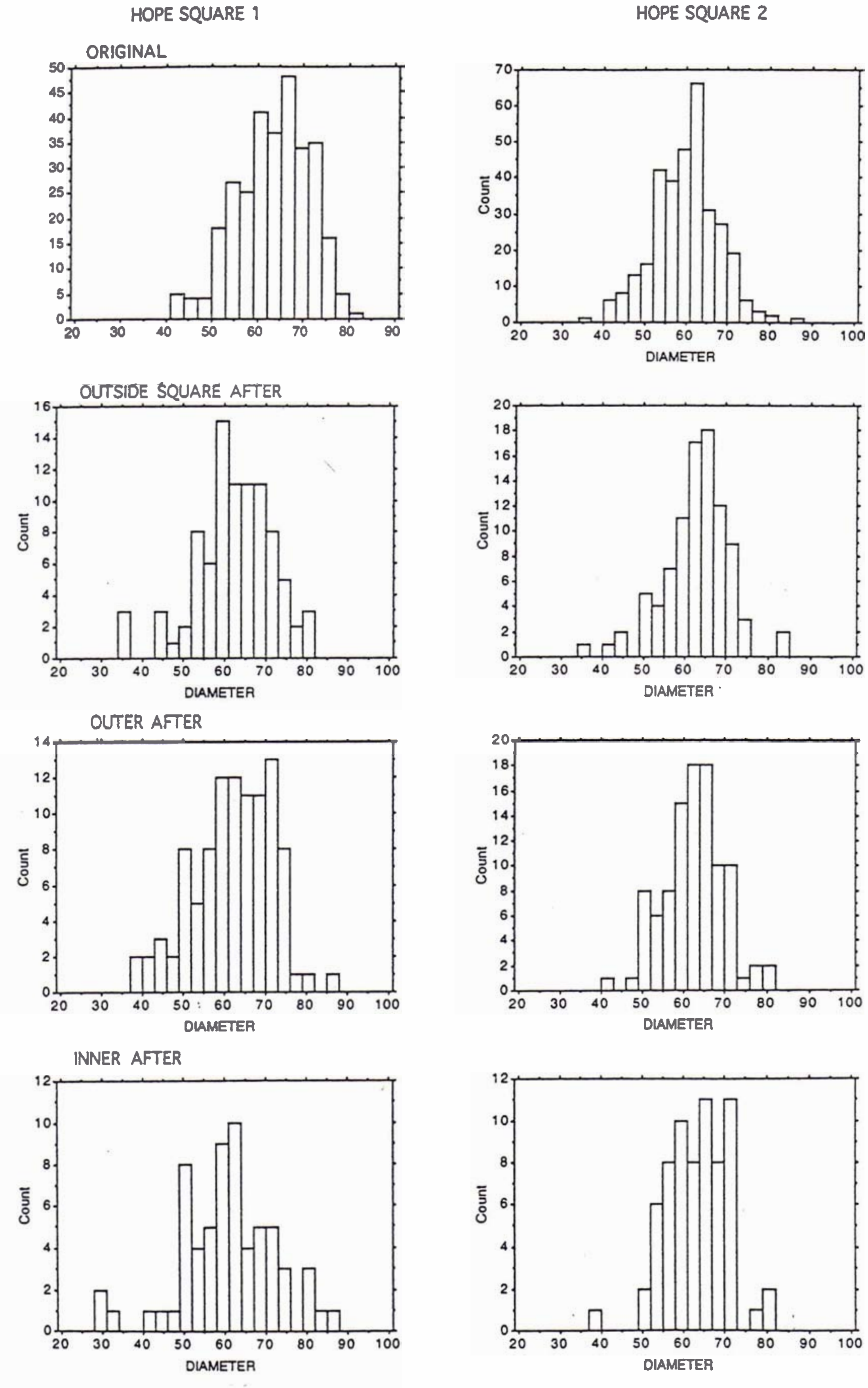


FIGURE 7.8 Size frequency of for both squares at Meredith Pt.

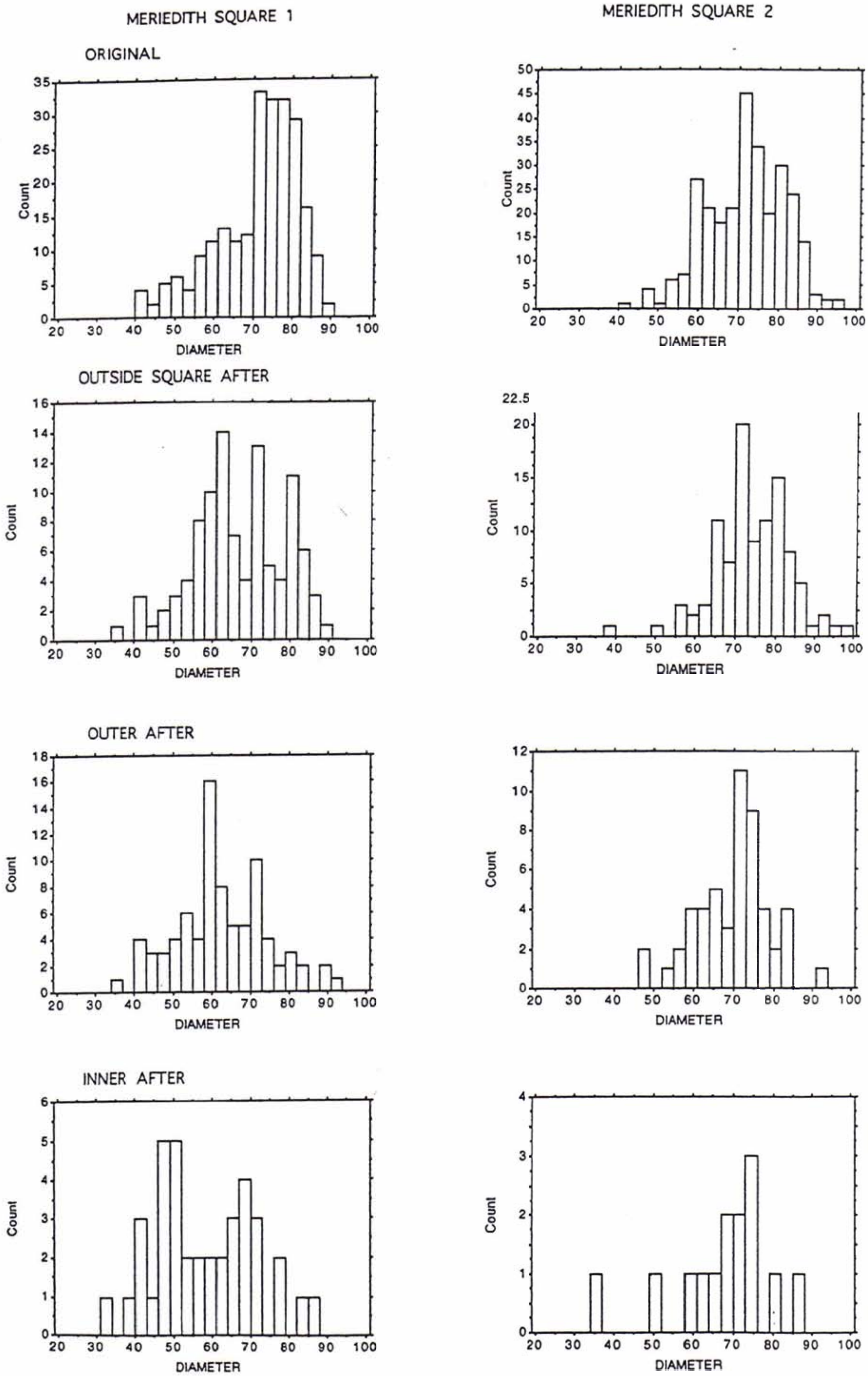
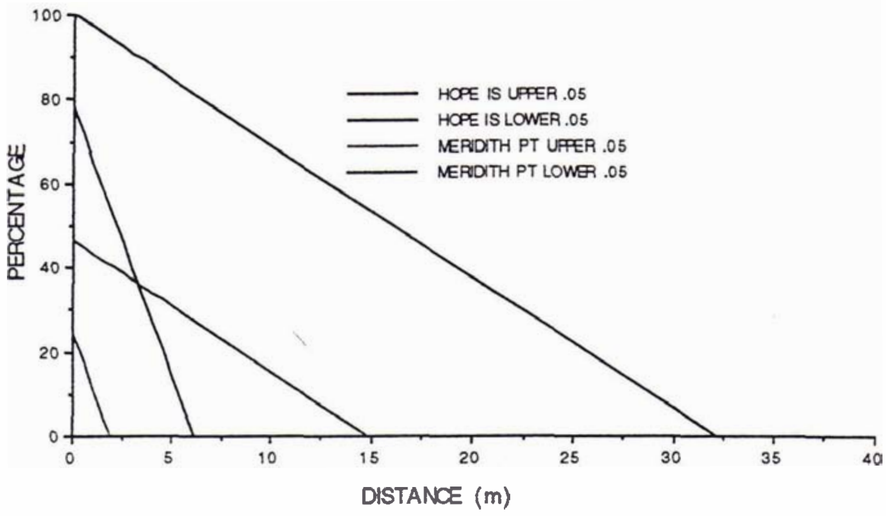
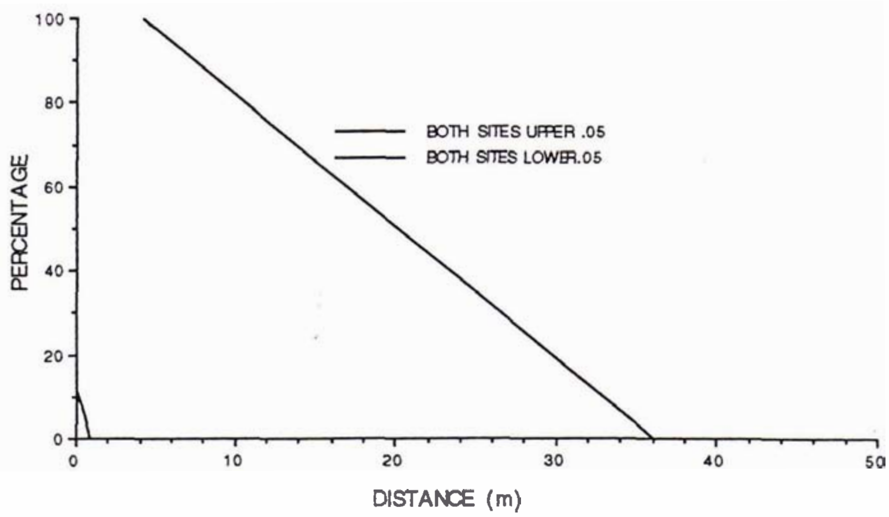


FIGURE 7.9 Estimated movement for both sites (top) and for both sites combined (bottom). Densities expressed as a percentage of outside square densities.

ESTIMATED MOVEMENT AT THE TWO SITES FOR THE YEAR 1994/95



ESTIMATED MOVEMENT FOR YEAR 1994/95 FOR BOTH SITES COMBINED



SECTION 8: KING ISLAND

INTRODUCTION

One of the factors limiting expansion of the urchin fishery is the lack of knowledge of condition of urchins outside the south eastern part of Tasmania. As part of this program some exploartory work was done at remote sites. This section shows results for King Is.

METHOD

In July of 1995, urchins from King Is were sampled for roe quality and quantity. To quicken the sampling process to get as many sites sampled as possible within the time on the island, for each of the sites, 25 urchins were collected, diameters measured , roe extracted and combined roe weight recorded. Individual weights of urchins were extrapolated from a diameter/weight relationship obtained from sites in SE Tasmania, a relationship which is conservative. At two of the sites, size frequency of 1-200 urchins was also determined. At one of the sites, a 100m transect was deployed and urchins were counted in 20 contiguous 5 x 1 m quadrats on either side of the transect.

Figure 8.1 shows where the sites were located on the island.

RESULTS

Day 1 Naracoopa

Site 1 (1/1)

Dominant algae: Caulerpa obscura (?), Caulerpa pentaflexa (?), Caulerpa flexilis, Macrocystis angustifolia with Caulocystis in shallow

Site 2

Exposed: Cystophora moniliformis, Ecklonia radiata, Phyllospora comosa, Macrocystis angustifolia, Acrocarpia panniculata in shallow (no sample).

Site 3 (1/2)

Acrocarpia pannculata, Cystophora moniliformis, Cystophora grevillaea (?), Caulerpa obscura, Ecklonia radiata and Sargassum sp.

Site 4

Ecklonia radiata, Macrocystis angustifolia, Sierococcus axillaris, Cystophora platylobium (no sample).

Site 5

Phyllospora comosa, Durvillaea potatorum, Macrocystis angustifolia (no sample).

Day 2 Christmas/New Years Island

Site 1 (2/1): Reef between islands and mainland King Is

Site 2 (2/2): Inside Christmas Island

Site 3 (2/3): Approx 200m inside Christmas IS

Day 3 (3/1) Councillor Is

Day 4 Grassy

~~**Site 1 (4/1): Reef between islands and mainland King Is**~~

Site 2 (4/2): Inside Christmas Island

Site 3 (4/3): Approx 200m inside Christmas IS

TABLE 1 Percent recoveries, for sampled urchins for King Is, July 95.

	SITE NO.									
	1.1	**1.2**	**2.1**	**2.2**	**2.3**	**3.1**	**4.1**	**4.2**	**4.3**	**AV.**
Roe Grade										
A	0.75	1.36	1.46	2.63	1.63	1.48	1.05	1.44	3.40	1.69
B	2.52	3.57	4.18	1.69	4.50	3.70	5.37	3.06	3.40	3.55
C	2.84	2.64	0.78	2.12	0.92	1.83	1.82	0.98	2.13	1.78
A+B	3.27	4.93	5.64	4.32	6.13	5.18	6.42	4.50	6.80	5.24

See Table 2 for results of transect undertaken at Councillor Is.

DISCUSSION

Overall, considering the samples were taken out of season, roe recoveries were reasonable, enough to warrant further investigation of King Is.

KI COUNCILLOR IS DATA

COUNCILLOR IS 8/7/95																							
QUADRAT		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
Urchins		26	7	5	15	26	15	21	1	15	3	11	13	22	6	24	19	6	12	5	40	29	12	15.1
Depth (feet)		27	24	24	26	24	26	27	25	25	28	22	24	22	25	26	28	30	31	28	31	25	24	2.11
Rock		100	100	100	100	100	50	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	
Cobble							50																	
Caulerpa brownii	C	15	40		5		2				2	2	2	5	2	5					2	2	2	
Caulerpa geminata	C	80	40	30	60	50	40	30	15	40	30	15	20	20	30	50	30	15	15	20	20	20	20	
Caulerpa obscura	C												1		15		15	10	10	5	2		5	
Caulerpa simpliciuscula	C			5	10		2	5			10	1			2	5	2	2		5	5	2	2	
Codium	C	1									1							1						
Acrocarpia panniculata	P													1	1		1	1	1					
Caulocystis (uvifera)	P						1																	
Cystophora moniliformis	P	5	4	2	2		2		5	5	2	15	10	5	5	5	2	2		5	2	5	2	
Ecklonia radiata	P													1									1	
Perithalia caudata	P														1									
Sargassum (heteromorphum?)	P	1				1	1		2	2	5	2		5		5				2	5	5		
Xiphophora gladiata	P	1		1					5			5	2	10	10	5	2	2	5	5	5	5	5	
Zonaria	P																					1		
Corallina	R							1																
Reds	R					1							1											

FIGURE 8.1 Sites sampled for roe recovery, king Island, july 1995.

FIGURE 8.2 Size frequencies for urchins at two sites on King Is.